New Scientist

WEEKLY 24 September 2022

FRESH INSIGHTS INTO WHY WE AGE

SHOULD YOUR DOG OR CAT GO VEGAN?

BLACK HOLES AND THE ORIGINS OF SPACE-TIME

NEW WAY TO TREAT LUPUS

NATURE NURTURE *LUCK*

A startling new theory on what makes you *you*

EINSTEIN WAS RIGHT, AGAIN

General relativity passes satellite test

PLUS HOW SATURN GOT ITS RINGS / **BEST WAY TO SOOTHE A BABY** / **IS JET LAG WORSE IF YOU TRAVEL EAST?** / DEFINING A NEW SPECIES

No3405 £6.95 CAN$9.99

abrdn

To get the right balance, get the right expertise.

Murray International Trust

So, you want to generate a healthy income and grow the value of your capital. It's a common request – but it requires uncommon expertise.

At Murray International Trust, we're dedicated to seeking out companies from across global markets that are well positioned to deliver the right blend of growth and income generation.

And because we insist on conducting our own first-hand company research, you can be confident we're working to deliver the very best balance of investments we can find.

Please remember, the value of shares and the income from them can go down as well as up and you may get back less than the amount invested.

Request a brochure: 0808 500 4000

murray-intl.co.uk

Issued by Aberdeen Asset Managers Limited, registered in Scotland (SC108419) at 10 Queen's Terrace, Aberdeen, AB10 1XL, authorised and regulated in the UK by the Financial Conduct Authority. Please quote 2918.

This week's issue

On the cover

36 Nature, nurture, luck
A startling new theory on what makes you you

15 Einstein was right, again
General relativity passes satellite test

New Scientist
NATURE
NURTURE
LUCK
EINSTEIN WAS RIGHT, AGAIN
BEST WAY TO SOOTHE A BABY
IS JET LAG WORSE IF YOU TRAVEL EAST?

Vol 255 No 3405
Cover image: Andrea Ucini

14 Fresh insights into why we age

44 Should your cat or dog go vegan?

41 Black holes and the origins of space-time

13 New way to treat lupus

20 How Saturn got its rings
20 Best way to soothe a baby
54 Is jet lag worse if you travel east?
26 Defining a new species

New Scientist Live

There are just two weeks to go until our flagship science show. Visit our website to see everything on offer, including newly added talks and speakers.

newscientistlive.com

News

8 Early puberty
Covid-19 pandemic linked to premature sexual development in girls

9 Closest black hole
Something very heavy is lurking 1500 light years away

10 Ethereum update
Cryptocurrency's big plan to save energy hasn't worked

Views

25 Comment
Our animal instincts can help tackle climate change, says Solitaire Townsend

26 The columnist
What makes a species new? Penny Sarchet weighs in

28 Aperture
Award-winning astronomy pics

30 Letters
More good reasons to stop burning wood at home

32 Culture
David Attenborough impresses again in *Frozen Planet II*

IVANMEL/SHUTTERSTOCK

14 Biological clock DNA tags let us estimate the age of any mammal

Features

36 Nature, nurture, luck
The third, mysterious element in the developing brain that controls who you become

41 Space-time origins
Brian Cox and Jeff Forshaw on how black holes are key to understanding the universe

44 Plant-based pets
Can you keep your cat or dog healthy on a vegan diet?

The back pages

51 Science with children
How to make an electric motor

53 Puzzles
Try our crossword, quick quiz and logic puzzle

54 *Almost* the last word
Could you decode a word written on a ball of string?

55 Tom Gauld for *New Scientist*
A cartoonist's take on the world

56 Feedback
This year's Ig Nobel prizewinning ideas and discoveries

Elsewhere on New Scientist

Academy

The science of you

As science is moving towards a more focused and personalised view of human health, discover new insights and cutting-edge research into your behaviour and well-being. Find out useful strategies you can take to improve your fitness, habits and diet – including the latest ideas on how to manage your microbiome. Join now for £99.

academy.newscientist.com

NS Live

Get your tickets today

New Scientist Live, the world's greatest festival of ideas and discoveries, returns next month. We have made ticketing cheaper and simpler this year: one ticket gives you access to everything at the show, including thought-provoking talks on four themed stages, interactive experiences, hands-on activities, workshops, performances and more than 80 exhibits. At ExCeL London from 7 to 9 October.

newscientistlive.com

Podcast

Weekly

Podcast editor Rowan Hooper combs the shores of Porthcressa beach on St Mary's in the Isles of Scilly, UK, to discover a solar-powered sea slug. The team also cover centenarians and extreme wildfires. Plus, they are joined by climate change artist and playwright David Finnigan to discuss his play *You're Safe Til 2024: Deep history*, which comes to London between 27 September and 1 October.

newscientist.com/nspod

PARKERPHOTOGRAPHY/ALAMY

Solar slugs Combing the shores of Porthcressa beach in the UK

BILLION PHOTOS/SHUTTERSTOCK

Daily meds Do multivitamins really keep our brains sharper?

Video

Beautiful universe

The winners of the Astronomy Photographer of the Year 2022 have been announced. We spoke to Edward Bloomer from the Royal Observatory, Greenwich, UK, about the finalists and the tricky business of judging astronomical images when you have the whole universe to play with. As you listen, you can view the incredible photographs that caught the judges' eyes.

youtube.com/newscientist

Newsletter

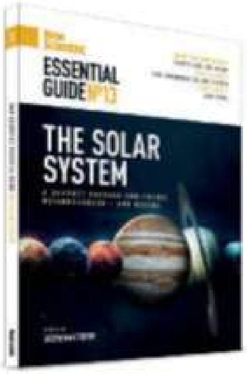
Health Check

This week, you may have seen articles claiming that taking a daily multivitamin and mineral supplement can help keep our brains sharper as we get older. Health reporter Clare Wilson delves into the detail and explains that while the results are intriguing, they aren't quite as definitive as you may think.

newscientist.com/health-check

Video

> **"The universe can make you feel very small, but also gives you that wonderful playground to explore"**



Essential guide

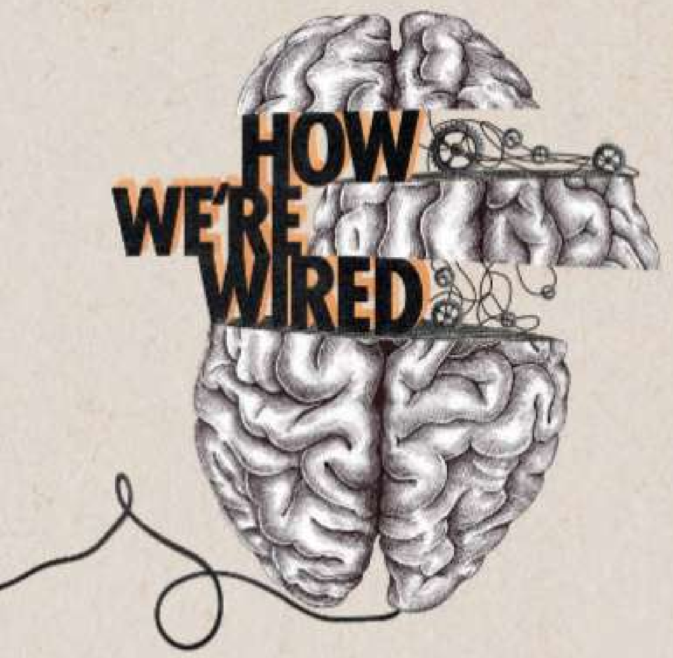
How does the sun work? Why does the moon matter? Is there alien life? Knowledge of our solar system has reached new heights – but there is still much to discover about our nearest planets and the worlds beyond. Explore more in the latest *New Scientist Essential Guide*.

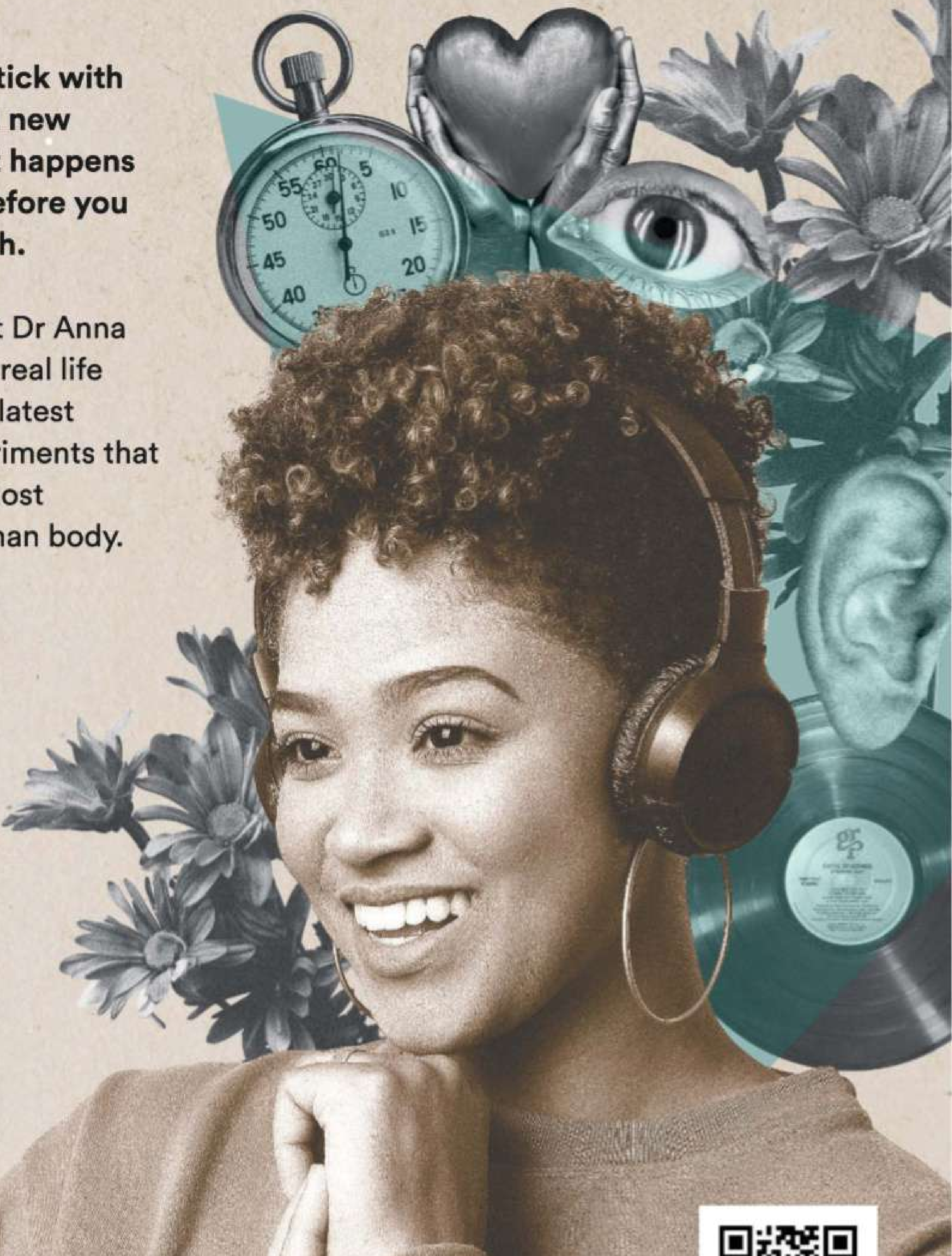
newscientist.com/shop

OWN YOUR MIND BUSINESS

Discover what makes you tick with How We're Wired, a brand new podcast that looks at what happens inside your brain – from before you were born through to death.

Presented by anthropologist Dr Anna Machin, this series features real life stories, expert analysis, the latest research and at-home experiments that will open your eyes to the most fascinating organ in the human body.





fondation bertarelli
fondation-bertarelli.org

Search for **'How We're Wired'** and subscribe wherever you get your podcasts.

Apple Podcasts · Google Podcasts · Spotify

New Scientist Subscriptions

INTRODUCTORY OFFER
12 WEEKS
FROM JUST £13.75

SAVE 83%*
New Scientist
INSTANT POWER
The electrifying promise of quantum batteries
CARBON FAILURE
How capture and storage facilities are under
PLUS TURNING PLASTIC INTO DIAMONDS
30 SECONDS OF NUCLEAR FUSION

Whether it's quantum batteries, artificial intelligence or the causes of fatigue – *New Scientist* answers the biggest questions surrounding the most fascinating topics.

Sign up today at newscientist.com/18578
or call: +44 (0) 330 333 9470, quoting 18578

Scan me to sign up

*Saving based on the full cover price of £6.95. Offer available on 'web', 'digital', and 'digital + print packages'. Prices start from £13.75 for web subscriptions. Other packages are also included in the offer. This is an auto-renewing subscription. In the unlikely event that you wish to cancel your subscription, we offer a 14-day cooling-off period after the initial payment is made. This offer ends 5 October 2022.

A lucky break

Who we become may depend more on chance than on parenting – so take a load off

DO YOU have your mother's DIY skills, your father's sense of humour or your granddad's love of cooking? What or who is to blame for your short temper, your inability to draw or your hatred of radishes?

Whether the differences between people are down to nature or nurture, genes or environment, has long divided scientists and philosophers alike. Now, it appears we have all been overlooking a third factor: sheer chance.

It turns out that random fluctuations of molecules inside our developing brain cells may play a role in their eventual wiring diagram, swaying developmental outcomes such as how extroverted, intelligent or resilient we are, as we report in our feature on page 36.

If this idea is accepted at large, it would be a welcome counterweight to the widely held notion that problematic parenting is to blame for personality and behavioural issues. Parent blaming is a profitable industry, as shown by the plethora of books, courses and websites on raising children that are available these days. Their conflicting advice on everyday things, such as food, discipline or screen time, can leave caregivers agonising over the minutiae of their decisions.

> **"This latest view is bad news for anyone seeking to mould their offspring in their exact image"**

In fact, most well-conducted genetic studies already show that, other than in cases of abuse or neglect, parenting styles have little lasting impact, so this new research won't be surprising to some. Nevertheless, it is fascinating that we are homing in on what is actually shaping us, outside of genes and environment – namely, a multitude of tiny inputs that are probably beyond parents' control.

This latest view of child development is bad news for anyone who would seek to mould their offspring in their image, but cheering for those with a less deterministic view of human destiny. It is clear that the workings of the human brain are complex and chaotic beyond our current understanding. For now, at least, let's hope this allows over-analysing caregivers a chance to take their foot off the gas and leave a few things up to luck. ▮

PUBLISHING & COMMERCIAL

Commercial and events director Adrian Newton

Display advertising
Tel +44 (0)203 615 6456 **Email** displayads@newscientist.com
Sales director Justin Viljoen
Account manager Matthew Belmoh, Mila Gantcheva
Partnerships account manager David Allard

Recruitment advertising
Tel +44 (0)203 615 6458 **Email** nssales@newscientist.com
Recruitment sales manager Viren Vadgama
Key account manager Deepak Wagjiani

New Scientist Events
Tel +44 (0)203 615 6554 **Email** live@newscientist.com
Sales director Jacqui McCarron
Head of event production Martin Davies
Head of product management (Events, Courses & Commercial Projects) Henry Gomm
Marketing manager Emiley Partington
Events and projects executive Georgia Peart

New Scientist Discovery Tours
Director Kevin Currie

Marketing & Data
Marketing director Jo Adams
Director of performance marketing and audience development Jeffrey Baker
Head of campaign marketing James Nicholson
Head of customer experience Emma Robinson
Head of audience data Rachael Dunderdale
Senior email marketing executive Natalie Valls
Email marketing executive Ffion Evans
Digital marketing manager Jonathan Schnaider
Senior customer experience marketing manager Esha Bhabuta
Senior marketing executive Sahad Ahmed
Marketing executive Tilly Howarth
Marketing assistant Charlotte Weeks

Digital Products
Digital product development director Laurence Taylor

Technology
Chief operations officer International Debora Brooksbank-Taylor
Technology director Tom McQuillan
Maria Moreno Garrido, Dan Pudsey, Amardeep Sian, Piotr Walków
Front end developer Damilola Aigoro
Junior front end developer Matthew Staines
Program manager Jennifer Chilton

NewScientist

Chief executive Nina Wright
Executive assistant Lorraine Lodge
Team administrator Olivia Abbott

Finance & operations
Chief financial officer Amee Dixon
Financial controller Taryn Skorjenko
Commercial finance manager Charlotte Thabit
Commercial finance manager Anna Labuz
Management accountant Charlie Robinson
Commercial management accountant Alexandra Lewis

Human resources
Human resources director Shirley Spencer
HR business partner Purnima Subramaniam

CONTACT US
newscientist.com/contact

General & media enquiries
UK **Tel** +44 (0)203 615 6500
Northcliffe House, 2 Derry Street, London, W8 5TT
Australia 58 Gipps Street, Collingwood, Victoria 3066
US PO Box 80247, Portland, OR 97280

UK Newsstand
Marketforce UK Ltd **Tel** +44 (0)33 0390 6555

Syndication
Tribune Content Agency **Tel** +44 (0)20 7588 7588
Email tca-articlesales@tribpub.com

Subscriptions
newscientist.com/subscription
One year print subscription (51 issues) UK £270
Tel +44 (0)330 333 9470
Email subscriptions@newscientist.com
Post New Scientist, Rockwood House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH

© 2022 New Scientist Ltd, England. New Scientist is published weekly by New Scientist Ltd. ISSN 0262 4079. New Scientist (Online) ISSN 2059 5387. Registered at the Post Office as a newspaper and printed in England by Precision Colour Printing Ltd

EDITORIAL

Editor-in-chief Emily Wilson
Magazine editor Catherine de Lange
News and digital director Penny Sarchet
Creative director Craig Mackie

News
News editor Jacob Aron
Assistant news editors Chris Simms, Alexandra Thompson, Sam Wong
Reporters (UK) Michael Le Page, Matthew Sparkes, Clare Wilson, (Aus) Alice Klein
Trainees Jason Arunn Murugesu, Alex Wilkins
Intern Carissa Wong

Digital
Audience editor Matt Hambly
Podcast editor Rowan Hooper
Web team Emily Bates, Chen Ly, David Stock

Features
Deputy head of features Daniel Cossins, Helen Thomson
Editors Colin Barras, Abigail Beall, Anna Demming, Kate Douglas, Alison George, Joshua Howgego
Feature writer Graham Lawton

Culture and Community
Comment and culture editor Alison Flood
Senior culture editor Liz Else

Subeditors
Chief subeditor Eleanor Parsons
Bethan Ackerley, Tom Campbell, Jon White
Trainee Tom Leslie

Design
Art editor Julia Lee
Joe Hetzel, Ryan Wills

Picture desk
Picture editor Tim Boddy

Production
Production manager Joanne Keogh
Production coordinator Carl Latter

New Scientist US
US Editor Tiffany O'Callaghan
Editors Timothy Revell, Chelsea Whyte
Reporters Leah Crane, James Dinneen, Jeremy Hsu, Karmela Padavic-Callaghan, Grace Wade, Corryn Wetzel
Subeditor Alexis Wnuk

Sign up for free

THE
KNOWLEDGE
NEWS MADE MANAGEABLE
Your five minute daily newsletter

A five minute daily newsletter from the founder of The Week, that brings together all the things that matter from the world's best news sources.

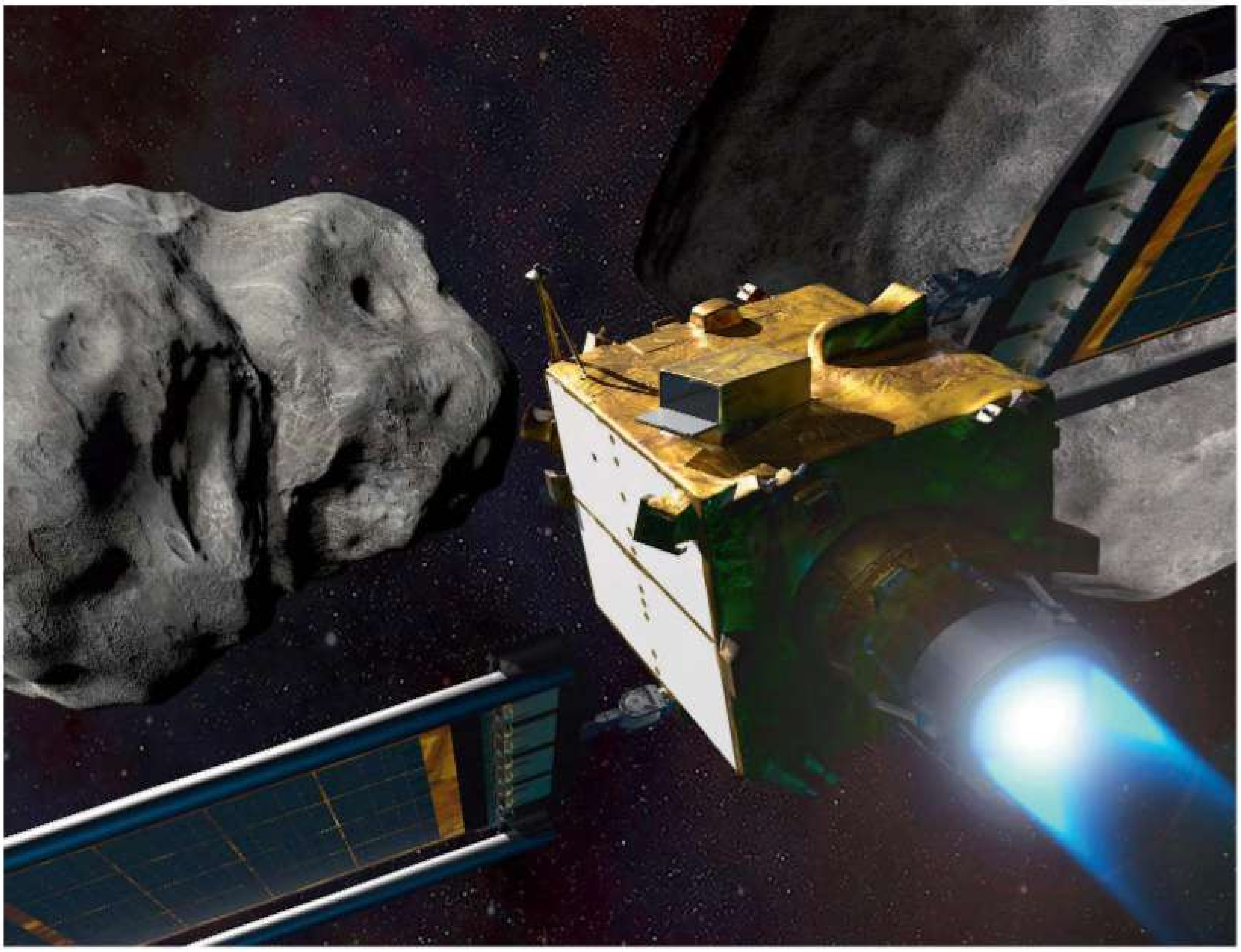
Eat that
The brain areas that light up when we look at food **p10**

New view of Mars
James Webb Space Telescope examines our neighbour **p11**

Weedkiller
Hot foam may be greener alternative to herbicides **p12**

Creepy images
Why AIs keep creating nightmarish characters **p16**

Climate warning
Floods show cities must plan for extreme weather **p18**



NASA

Artist's impression of DART and its asteroid target

Space

Testing Earth's defences

The first attempt to divert an asteroid could one day help prevent an impact on our home planet, reports **Alex Wilkins**

NASA's Double Asteroid Redirection Test (DART) spacecraft will smash into an asteroid next week, in the first ever real-world planetary defence mission.

The 500-kilogram DART craft launched on 24 November 2021 and is scheduled to reach its destination, the 780-metre-wide asteroid Didymos, on 26 September. Once it arrives, it will purposefully crash into Didymos's moon, the 160-metre-wide asteroid Dimorphos, in an attempt to divert the smaller rock's orbit around its parent.

Neither Didymos nor Dimorphos presents a threat to Earth, being 11 million kilometres away, but mission scientist Andy Rivkin at Johns Hopkins University in Maryland and his team hope the asteroid system can act as a test-bed for dealing with potentially deadly space rocks.

"This is an experiment at the kinds of scales that we want to use, or that we might use, if we ever need to deflect an asteroid for real," said Rivkin during a press conference at the Europlanet Science Congress in Granada, Spain, on 19 September.

The researchers will deem the mission a success if DART's impact, which will be at around 6.6 kilometres per second, changes the length of Dimorphos's orbit by at least 73 seconds, give or take 10 per cent – but they think that the real diversion could be closer to around 10 minutes.

Although DART has a camera onboard, the spacecraft will be destroyed on impact, so won't be able to see the outcome. Instead, the team will rely on LICIACube – a sister spacecraft from the Italian Space Agency that separated from DART on 11 September – to take detailed observations.

> "This is an experiment at the scales we want to use if we ever need to deflect an asteroid for real"

At a distance of 55 kilometres from the impact crater, LICIACube will use two cameras to capture images and record data of the strike, as well as measure its kinetic impact on Dimorphos and any resulting plume from the crash site. "There will be an impact that will change the trajectory, there will be a crater formed and, after, there will be ejecta that will propagate through space and LICIACube will photograph this," said Stavro Ivanovski at the Astronomical Observatory of Trieste in Italy during the press conference.

There will also be support from several ground-based telescopes and space observatories, including Hubble and James Webb, which will take measurements of Didymos's orbit and compare it with past observations. "When Dimorphos moves in front of Didymos, we can see a brightness drop due to the shadow," said Rivkin. "By measuring this brightness go up and down, we'll be able to measure the period that it takes for Dimorphos to go around Didymos."

While observations of the impact itself will be transmitted to Earth shortly after it happens, its effect on Dimorphos's orbit will take weeks or even months to measure to a high precision and thus reveal whether the mission was a success, said Rivkin. Alongside LICIACube's measurements, the European Space Agency plans to launch a spacecraft called Hera in 2024 to record the impact's aftermath in more detail. ▮

New Scientist Live
Join Patrick Vallance as he outlines the case for why science in government matters newscientistlive.com

Covid-19

Pandemic linked to early puberty

The global coronavirus outbreak may be more than doubling the number of girls going through premature sexual development, finds **Elizabeth Hlavinka**

THE covid-19 pandemic may be triggering early puberty in some girls.

Several studies suggest the outbreak is increasing the number of girls going through premature sexual development – and experts are unsure why.

In the latest of a string of studies, researchers at the University of Bonn, Germany, reported how the number of girls diagnosed with early puberty at a single medical centre remained constant between 2015 and 2019, at fewer than 10 cases a year.

This more than doubled to 23 in 2020, when the covid-19 outbreak took hold worldwide, rising further still to 30 in 2021, according to results presented at the 2022 meeting of the European Society for Paediatric Endocrinology last week.

These researchers aren't the only ones to see cases double. "In the pre-covid year, we had 28 children start treatment and in the covid year, we had 64 children start treatment," says Karen Klein at Rady Children's Hospital and the University of California, San Diego.

Similar results have also been reported in Turkey and Italy.

Unclear cause

Early puberty is rare, affecting 1 in 5000 to 10,000 children in pre-pandemic times. For every one boy, it affects 10 girls. The reasons behind this disparity are unclear.

Regardless of a person's sex, early puberty is linked to short stature in adulthood, as well as a greater risk of serious health conditions, such as heart disease, type 2 diabetes and some cancers.

Early puberty has also been associated with certain mental health problems, such as anxiety in boys and depression in girls.

ASTRAKAN IMAGES/GETTY IMAGES

The covid-19 pandemic may be triggering early puberty in some girls

Sezer Acar at Dr. Behçet Uz Children's Education and Research Hospital in Izmir, an author of the Turkish study linking increased rates of early puberty to the pandemic, says: "Previously, I [treated] one or two patients a month due to precocious puberty, but during this period [the early stages of the pandemic before his study was published], I had to treat two or three patients a week."

In addition to an increased number of girls starting puberty early, the age of onset may have also declined.

In the German study, pre-pandemic puberty onset occurred at age 6.8, on average, compared with 7.6 among those diagnosed during the covid-19 outbreak. A statistical analysis suggests this wasn't a chance finding.

"We know stress can cause earlier puberty, so that's certainly high on the list of what's going on," says Klein.

"The other thing people immediately started to think about was, well, everyone is at home not exercising as much and maybe it's weight gain, because we know rapid weight gain can cause earlier puberty," she says. "But in our study and in a couple of other studies, we didn't see that the children were heavier."

> "We know stress can cause earlier puberty, so that is certainly high on the list of what is going on"

Increased screen time and changes in sleep cycles due to remote learning could also be at play, says Paul Kaplowitz at the Children's National Hospital in Washington DC. These factors weren't assessed in all the studies.

However, in a follow-up study to the Italian paper on increased rates of early puberty, researchers found that girls who were diagnosed with early puberty during lockdown had more disturbed sleep and later bedtimes than those diagnosed pre-pandemic.

Some have questioned whether the SARS-CoV-2 coronavirus itself is to blame. Inflammation of the nasal cavity has been documented in covid-19 cases and in people going through early puberty. Although this hypothesis can't be ruled out, especially because many childhood covid-19 cases are mild and may be missed, it seems unlikely, says Kaplowitz.

"I don't think the effect of covid on female puberty is restricted to girls who actually had the infection," says Kaplowitz. "Especially since, in the earlier stages of the pandemic, children were much less likely to become infected than adults."

The pandemic aside, the age of puberty onset has been declining by about three months per decade since 1977, although there is little data on the effect of other traumatic events like wars or recessions.

Medication can reduce hormone levels and stunt sexual development for several years. However, this is generally only recommended if early puberty is expected to cause emotional or physical problems.

Some doctors hope that the return of in-person schooling and children adapting to pandemic-related challenges will slow the rate of early puberty.

"When the data is looked at for the past year, particularly in places where kids almost all went back to school and life returned to more normal, I would predict that the rate of precocious puberty will return to what it had been previously," says Kaplowitz. "But we obviously don't know." ▮

Astronomy

Closest black hole to Earth could be visible in the skies of nearby planets

Jonathan O'Callaghan

THE closest known black hole may have been found a cosmic stone's throw from Earth, just 1500 light years away. Called Gaia BH1, it is estimated to be about 10 times the mass of our sun.

Although it can't be seen directly because it emits no light, data from the European Space Agency's Gaia space telescope revealed the gravitational tug the black hole exerts on its orbiting companion star, which is similar in age and mass to our own sun.

Several candidates for nearby black holes have been found before, but most haven't stood up to scrutiny. However, Kareem El-Badry at the Harvard-Smithsonian Center for Astrophysics in Massachusetts and his colleagues say their discovery is the best candidate yet for such an object (arxiv.org/abs/2209.06833).

"This one is solid," says team member Tsvei Mazeh at Tel Aviv University in Israel. "I'm ready to bet my life on it."

PANSTARRS/EL-BADRY ET AL

Gaia BH1 is invisible but located at the centre of this image

Many black holes have been discovered before, such as merging black holes seen by the gravitational waves they produce, and others eating stars in binary systems, making them shine brightly in X-rays. Astronomers using the Event Horizon Telescope have also directly imaged two of these cosmic behemoths.

Dormant black holes like Gaia BH1 have been harder to find, due to their near invisibility. "These black holes are far from any source of food," says Lukasz Wyrzykowski at the University of Warsaw in Poland – Gaia BH1's star orbits the black hole at about the same distance Earth orbits the sun.

It isn't clear how this system formed. One possibility is that the black hole was originally a much more massive star that expanded into a red supergiant and then collapsed, perhaps with an accompanying supernova, although it is unlikely that its companion star would have survived. Another scenario is that the black hole could actually be two black holes, making this originally a triple-star system. Alternatively, the companion star could have been captured by the black hole when passing.

El-Badry hopes to find out with observations using other telescopes, looking for evidence of a binary black hole or even planets orbiting the star, which could suggest a lack of an explosive event. "It could definitely have planets," he says. "If you lived on a planet around the star, the black hole would be as bright as Jupiter", as it eats a small amount of the star's solar wind, he says.

In a few billion years, the black hole's companion star is expected to expand into a red giant, like our sun, which will massively increase the fuel going into the black hole and make it far brighter in any nearby planet's sky. "One hundred thousand times brighter than the sun," says El-Badry.

1500

Distance to the black hole from Earth, in light years

Gaia should find dozens more of these dormant black holes in our galaxy, of which there could be tens of thousands. Systems like Gaia BH1 would be prime targets for learning more about black holes. "We don't normally get chances to study these extremes of physics," says Wyrzykowski. ■

Environment

Urban trees are threatened by climate change

CITIES around the world may need to start planting different types of trees and shrubs that can tolerate warmer and drier conditions. By 2050, about three-quarters of the species currently grown in urban environments will be at risk as a result of climate change, a study has found.

"By 'at risk', we mean these species might be experiencing stressful climatic conditions," says Manuel Esperon-Rodriguez at Western Sydney University in Australia. "Those trees are likely to die."

City trees have many benefits, from making urban spaces look beautiful and providing a refuge for wildlife to keeping places up to 12°C cooler than they would otherwise be in summer. Losing tree cover would lead to cities becoming even hotter as the planet heats up.

To assess the threat, Esperon-Rodriguez and his colleagues used a database called the Global Urban Tree Inventory to work out the conditions required by 3100 tree and shrub species currently grown in 164 cities worldwide. The researchers then looked at how these conditions would be affected by climate change under a medium-emissions scenario known as RCP6.0.

By 2050, 76 per cent of these species will be at risk from rising average temperatures and 70 per cent from decreasing rainfall, the team concludes (*Nature Climate Change*, doi.org/jcz9).

SHUTTERSTOCK/LENA IVANOVA

The Tuileries Garden in Paris is being restored with a wide variety of tree species

The study doesn't take account of continued urban growth, which could warm cities even faster. Nor does it take account of greater weather extremes caused by climate change, or the effects of pests and diseases. Warmer conditions are allowing more pests, such as bark beetles, to survive winters as well as to reproduce faster in summer, greatly increasing their impact. "Our estimates are conservative," says Esperon-Rodriguez.

There are some things that can be done to help trees survive. The best strategy is to choose resilient species when replacing trees or planting new ones, the team concludes. ■

Michael Le Page

Neuroscience

Brain scans reveal areas that respond to pictures of food

Jason Arunn Murugesu

TWO regions of the brain have been discovered that react most strongly to images of food.

Researchers have previously identified regions of the brain's visual system that are selectively activated by faces, places and written words, but no such region had been conclusively found that was activated by looking at food.

To investigate further, Leila Wehbe at Carnegie Mellon University in Pittsburgh, Pennsylvania, and her colleagues analysed data from a year-long study in which eight people looked at 10,000 different pictures while they had their brains scanned in a functional magnetic resonance imaging (fMRI) machine. The pictures typically contained more than one object and were similar to photographs that would be taken in everyday life.

The researchers took 1000 of these shots that had been seen at least once by each participant and analysed the corresponding fMRI data. More than half of the images were seen by each participant three times over the course of a year. "fMRI data tends to be noisy and using the same stimulus multiple times means you can average across the repetitions of the stimulus and get a cleaner image," says Wehbe.

The team identified two brain regions in all the participants that were preferentially activated by images of food. These regions were in the ventral visual cortex and were on either side of an area implicated in facial recognition (bioRxiv, doi.org/jcw3).

Meenakshi Khosla at the Massachusetts Institute of Technology says foraging is one of the brain's most important functions. "Food is not just sustenance, but also has a distinctive importance in human culture," she says. ▮

Cryptocurrency

Ethereum's eco update sees miners migrate to other coins

Matthew Sparkes

A RADICAL update to the Ethereum cryptocurrency was supposed to reduce energy consumption by 99 per cent, but savings on that scale have so far failed to materialise as miners evicted from the network flock to other currencies. Estimates suggest that at least 50 per cent of energy hungry mining hardware formerly running Ethereum has now been put to use mining other coins.

In a long-awaited and much-delayed update on 15 September called the Merge, Ethereum shifted from a proof-of-work (PoW) model – where lots of computer power was devoted to "mining" new coins and verifying transactions – to a greener, proof-of-stake model. Under the new system, instead of using computer hardware to mine new currency to get a reward, money is lodged with the network to gain the right to validate transactions and get rewarded.

The move was, in part, a reaction to a major criticism levelled at cryptocurrencies: their vast energy consumption. By some estimates, Ethereum was drawing about 83 terrawatt-hours (TWh) per year before the Merge, about as much as all of Chile's electricity use, while bitcoin uses about 96 TWh per year, a little less than Pakistan.

In theory, the vast bulk of Ethereum's energy consumption has now dropped away, and the largest mining group, Ethermine, announced that it would withdraw entirely from the industry. But large numbers of disgruntled miners who are left with hugely expensive, specialised hardware and no source of income have decided to continue harvesting other coins, with all the associated energy use.

83 TWh

Ethereum's annual energy use before the Merge update

Three other cryptocurrencies, Ergo, Ethereum Classic and Ravencoin, have seen big increases in their hashrate – a measure of the computer power devoted to mining – since the start of the month. These currencies also saw a spike in price as miners turned to them, which, in turn, created a greater incentive for others to join.

A large group of miners also chose to create an entirely new project that split from Ethereum at the point of the Merge. This "EthereumPoW" network saw its hashrate jump from 0 to 80 terahashes per second on 15 September. The group behind the project didn't respond to a request for comment.

Those jumps together make up a significant portion of the mining power that left the Ethereum network at the point of the Merge.

Tim Beiko at the Ethereum Foundation, which acts as an oversight organisation for the network and can, to an extent, steer its development, says the Merge could lead to a boost for other cryptocurrencies, but this wouldn't last. "Unless these networks capitalise on the new attention to build something, it's hard to see why the price, and hence value of the daily mining rewards, would stay high," he says. "My gut feeling is very much that the extra hashrate migrating to other networks is a temporary phenomenon."

There are already signs that smaller miners have been pushed out by the arrival of bigger players. Trane Francks, a former Ethereum miner, says he switched to mining other currencies prior to the Merge, but that the influx of larger mining outfits has already made this unprofitable. "Currently, based on my electricity costs in Tokyo, it is not profitable to mine," he says. ▮

AKOS STILLER/BLOOMBERG VIA GETTY IMAGES

A worker at a crypto mining facility in Romania

New Scientist Live
Learn all about the cosmos on the Universe Stage
newscientistlive.com

Astronomy

JWST snaps its first Mars pics

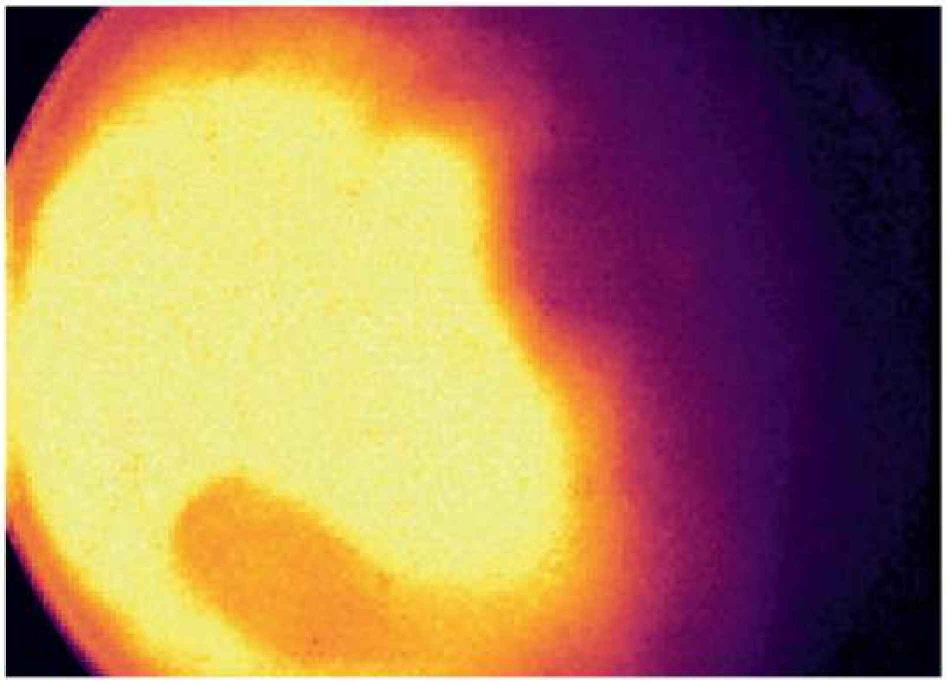
As well as staring deep into the cosmos, James Webb can look closer to home

Alex Wilkins

THE James Webb Space Telescope (JWST) has released its first images of Mars, capturing atmospheric data for the entire planet that will help astronomers identify phenomena and gases that previous instruments couldn't.

"Now you can actually get these full images of the planet in the whole infrared range at incredible sensitivities," says Geronimo Villanueva at the NASA Goddard Space Flight Center in Maryland.

This image shows the eastern hemisphere of Mars in infrared, revealing information about heat emitted from the Martian surface and atmosphere (brighter is hotter), as well as the levels of carbon dioxide in the atmosphere.



The planet Mars seen in infrared by the JWST telescope

NASA/ESA/CSA/STSCI/MARS JWST/GTO TEAM

Imaging close planets like Mars is difficult for an instrument like JWST, which was designed to detect very distant, faint objects. The sunlight reflected from Mars overloads JWST's detectors, so Villanueva and his team had to adapt by taking short exposures and only sampling some of the light from the detectors.

Mars was especially tricky to capture because it moves relatively quickly around the solar system, whereas JWST typically images objects that barely move relative to other stars. "The fact that, when we opened the images and when we got the spectra, we actually could get the data and they were good data, it was exciting," says team member Sara Faggi.

The first images and spectra of Mars from JWST haven't revealed anything we didn't already know about the planet, identifying dust, surface rocks and atmospheric features like water and carbon dioxide, but they do serve as a proof of concept for collecting data that other telescopes can't.

One advantage of using JWST to look at Mars is that an entire face of the planet can be imaged at once in high resolution at a short exposure time, which should allow for the study of events that happen over a short timescale, like dust storms, weather patterns and seasonal changes.

This full picture will also allow scientists to more easily track down the sources of any trace gases that they spot. "Hunting for these particular [chemical] species and, eventually, identifying the sources of these species is a work that can be done in a much more promising way with JWST," says team member Giuliano Liuzzi. ▮

Coronavirus

Omicron variant may protect against flu

BEING infected with the omicron variant of the coronavirus may give some protection against flu.

Martin Michaelis at the University of Kent in the UK and his colleagues collected bronchial cells from a person with emphysema, a condition where the lungs' air sacs are damaged, but the bronchi airways are unaffected.

The cells were extracted as part of a standard diagnostic or treatment procedure. With the bronchi being unaffected by emphysema, the results are expected to apply to people without the condition, according to Michaelis.

In a laboratory study, the bronchial cells were infected with the delta variant of the SARS-CoV-2 coronavirus or one of two omicron subvariants, BA.1 or BA.5. As a control, the researchers treated some cells with a saline solution.

After two days, the team exposed all the cells to the H1N1 strain of influenza virus, which circulates every winter.

One day later, the researchers measured the H1N1 levels in all the cells. In the control cells and those infected with the delta variant, H1N1 levels increased roughly 10,000-fold (bioRxiv, doi.org/jc2b). This is compared with no increase in the cells that contained either omicron subvariant.

The team also found that the cells containing the omicron subvariants produced a protective immune response called the interferon response, which is known to reduce the replication of flu viruses. Among the control cells and those infected with the delta variant, this response was much lower and insufficient to suppress H1N1 replication.

The findings may be reflective of changing SARS-CoV-2 and flu infection rates over the pandemic. "Following the lifting of restrictions in July 2021 in England, we saw a delta wave accompanied by an increase in influenza-like illnesses," says Michaelis. "But then, since omicron BA.1 became dominant, influenza-like illnesses dropped and have stayed low."

> "We don't advise people to purposely get infected with covid-19 to protect against influenza"

However, this could be due to people being more careful to avoid infections during winter, he says.

Understanding how covid-19 variants trigger varying immune responses may help researchers more quickly understand the potential impact of new variants.

"We, of course, don't advise people to purposely get infected with covid-19 to protect against influenza. With SARS-CoV-2 infection, there's always a chance you could die," says Michaelis. ▮

Carissa Wong

Climate change

AI can test 100 years of climate policy in seconds

Jeremy Hsu

A SIMULATION using AIs can hammer out 100 years' worth of climate negotiations in just a few seconds. It is part of a competition launched last month to help find out which international policies have the best chances of success.

With time running short for countries to agree on how to reach net-zero greenhouse gas emissions by 2050, the AI for Global Climate Cooperation – a collaboration of researchers from universities and firms like Salesforce and Google – has created a digital testing ground for climate policies and ideas.

The simulation is based on the work of William Nordhaus, who won a Nobel prize in 2018 for his research on climate economics. To assess the impact of policies such as a carbon tax, Nordhaus created the Regional Integrated model of Climate and the Economy (RICE) that captures how factors such as technological change, carbon dioxide emissions, global temperatures and the resulting economic damage interact.

The collaboration developed a new version of that model, called RICE-N, that adds negotiations to the mix. This allows fictional regions in the simulation to propose and form agreements through multiple rounds of negotiations.

A human kicks off the simulation by using one or more AI-controlled regions to propose a climate agreement, then the AIs representing 27 fictional regions negotiate by accepting or rejecting the proposal. After each negotiation phase, the simulation shows how the agreements shape each region's economic decisions and how those impact the climate. The negotiations occur every five years in a simulation run equivalent to 100 years.

The AIs use machine learning to figure out what regional interactions lead to the best economic and climate outcomes through trial and error, learning from each round how to do better the next time.

"If you actually think about global decision-making, nobody makes decisions in a vacuum," says Stephan Zheng at Salesforce in California. "What you want is to understand the relationships and the communication between countries."

The goal is for teams to suggest the policy incentives, such as a mix of trade rewards and tariff punishments, that get the model's self-interested AI agents to cooperate for the common good. "National short-term interests are the major stumbling block for achieving ambitious climate agreements," says Carola Kloeck, a political scientist at the Center for International Studies in France.

All proposals will be evaluated through RICE-N simulation scores that reflect how well the world has done in terms of climate and the economy. Top-scoring policies will also be reviewed by a human jury that considers whether they are ethical and can be implemented in the real world. Once the competition wraps up in April 2023, the plan is to publish a paper that could inform policy in real climate negotiations.

"Hopefully RICE-N can bring us closer to something that allows us to have a better understanding of the behavioural [or] human dimensions of climate change cooperation," says Stefano Carattini at Georgia State University.

The big question is whether a winning climate policy in the simulation would be similarly successful in the real world. "The simulation will necessarily be much more simple than reality," says Kloeck. ▮

Climate agreements are crucial to meet net-zero goals

LICENSED BY STORY PICTURE AGENCY/SHUTTERSTOCK

New Scientist Live
Could a trillion dollars solve the world's problems?
newscientistlive.com

Technology

Plant-based hot foam kills weeds as fast as chemicals do

Alice Klein

A HEATED, plant-based foam kills weeds as effectively as a commercial chemical spray and may be a safer, eco-friendlier alternative.

"It works very well regardless of the weed growth stage," says Ilias Travlos at the Agricultural University of Athens, who conducted an independent study of the hot foam at two small olive groves in Greece.

Spraying weeds with herbicides like glyphosate is a common way to remove them, but concerns over possible harm to animals have prompted a search for alternatives.

One chemical-free way to kill weeds is by applying heat, using devices like blowtorches, to make the plants shrivel up and die, but hot-water-based techniques haven't been as successful because the heat is lost quickly.

Now, UK company Weedingtech has developed a foam made of natural oils and sugars from plants like wheat and maize that can retain heat when mixed with hot water.

The mix is applied to weeds at 97°C (207°F) using a machine with a handheld spraying device. This creates a thermal blanket around the weeds that makes them die within 48 hours. The foam and dead weeds then biodegrade.

Travlos and his colleagues found that the hot foam worked as well as glyphosate at removing weeds in the two olive groves, reducing total weed biomass by about 96 per cent.

It was also superior to removal techniques like mowing or spraying with a plant-based weedkiller called pelargonic acid (*Smart Agricultural Technology*, doi.org/jcpr).

Several urban areas, including Glastonbury in the UK, have also successfully trialled the foam for removing weeds from pavements. Other non-herbicide weed control methods are also in development, including using electricity or lasers, or cutting down weeds with powerful water jets. ▮

Medicine

Radical treatment for lupus

A cell-based therapy developed for cancer has been adapted to fight the autoimmune disease

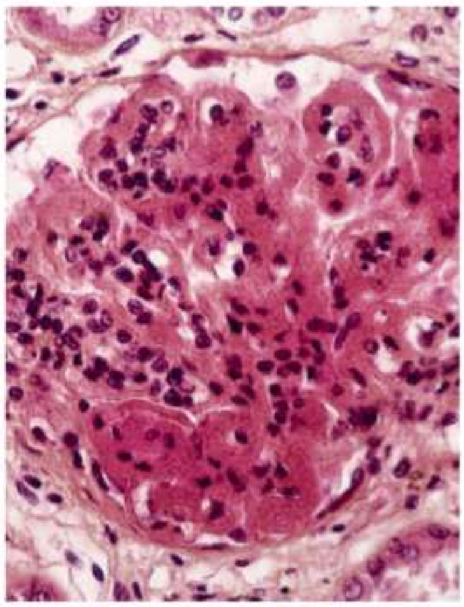
Clare Wilson

A HIGH-TECH cell therapy used to treat cancer has been repurposed as a treatment for lupus, an autoimmune condition that can cause joint, kidney and heart damage.

CAR T-cell therapy has put all five people with lupus treated so far into remission. The participants have been followed up for an average of eight months, with the first person treated 17 months ago. "That's kind of unheard of," says Chris Wincup at King's College London, who wasn't involved in the study. "This is incredibly exciting."

But it is too soon to know how long the remissions will last, says Georg Schett at the University of Erlangen-Nuremberg in Germany, who was part of the study team.

CAR T-cells were developed to treat blood cancers that arise when B-cells, a type of immune cell that normally makes antibodies, start multiplying out of control. The approach requires taking a sample of immune cells from a person's blood, genetically altering them in the lab so they attack B-cells and then infusing them back into the individual's blood. It seems to put 4 out of 10 people with these kinds of cancers into remission.



CNRI/SCIENCE PHOTO LIBRARY

A kidney tissue sample from a person with lupus, showing inflammation

Lupus, also called systemic lupus erythematosus, is caused by the immune system mistakenly reacting against people's own DNA. This is driven by B cells making antibodies against DNA released from dying cells.

The disease predominantly affects young women. It is currently treated with medicines that suppress the immune system or, in more severe cases, with drugs that kill B-cells. But the treatments can't kill all the B-cells, and if the disease flares up badly, some people develop kidney failure and inflammation of their heart and brain.

Schett and his team wondered whether using CAR T-cells to hunt down all the B-cells would be more effective. Within three months of receiving the treatment, all five participants were in remission, without needing to take any other medicines to control their symptoms.

The CAR T-cells were barely detectable after one month, and after three-and-a-half months, the volunteers' B cells started to return, having been produced by stem cells in the bone marrow. These new B-cells didn't react against the DNA (*Nature Medicine*, doi.org/gqtfgw).

We don't know what normally causes B-cells to start reacting against DNA in people with lupus, so it is possible that some kind of trigger may start the process happening again, says Wincup.

The achievement means CAR T-cells may also be useful against other autoimmune diseases that are driven by antibodies, such as multiple sclerosis (MS), in which the immune system attacks nerves, says Schett.

Another radical treatment for MS involves "rebooting" the immune system by destroying it with chemotherapy. By comparison, "CAR T-cells would be less invasive and more tolerable", he says.

But it is too soon to know how effective CAR T-cells will be for autoimmune conditions, says Wincup. "This is a small number of patients, so we don't know if this is going to be the result for everyone." ▮

Solar system

Mars rover keeps finding organic matter

NASA's Perseverance rover is exploring a long-dry river delta on Mars, and it has seen signs that indicate the region is full of organics – molecules containing carbon that are widely considered to be the building blocks of life.

The rover has taken samples and measurements in an area called Skinner Ridge, which is made of layered sedimentary rocks, some of which contain materials that were most likely transported from hundreds of kilometres away by running water billions of years ago.

"With the samples we're taking now in this more sedimentary area, we're of course right at the heart of what we wanted to do to start with," said NASA science lead Thomas Zurbuchen during a press conference on 15 September. The goal was to look at areas similar to those on Earth that harbour signs of ancient life, he said.

These sedimentary rocks contain complex organic molecules called aromatics, as well as clays and sulphate minerals, which can be produced when water interacts with rocks. While these materials aren't definitely signs of life, known as biosignatures, they do mean we are looking in the right place.

"This is really important that this has sulphate in it and also clays, because that means that this rock has high potential for biosignature preservation, meaning that if there were biosignatures in this vicinity when that rock formed, this is precisely the type of material that will preserve that for us to study when [the samples] come back to Earth," said David Shuster of the University of California, Berkeley, during the press conference.

> "If this is a treasure hunt for potential signs of life on another planet, organic matter is a clue"

The prevalence of organic matter has increased over the course of Perseverance's journey, travelling from the crater in which it landed towards the river delta. "If this is a treasure hunt for potential signs of life on another planet, organic matter is a clue," said Sunanda Sharma of NASA's Jet Propulsion Laboratory in California during the press conference. "We're getting stronger and stronger clues as we're moving through our delta campaign."

However, we probably won't be able to hunt for definitive signs of life in these rocks until samples are brought home in a mission planned for launch in 2028. ▮

Leah Crane

Genetics

Closing in on true cause of ageing

DNA clocks, which allow us to accurately work out how old almost any mammal is, are challenging old ideas of what really leads to ageing, discovers **Michael Le Page**

THE age of almost any mammal can now be accurately estimated from a tissue sample by analysing chemical tags on DNA. The finding comes from a study of nearly 200 species and could overturn our understanding of ageing.

The team involved says the fact that all mammals seem to have the same "ageing clocks" shows that ageing is the result of developmental programs that have been retained during the evolution of mammals, rather than being solely due to accumulating damage.

If something is conserved across different species, it is a sign that it is biologically important, says Steve Horvath at the University of California, Los Angeles, who led the work. "You simply would not be able to build these pan-mammalian clocks if there wasn't something here that's conserved."

The clocks are already being used by other teams to help study ageing and potential anti-ageing therapies. For instance, one team has shown that giving old mice young blood sets these clocks back in many organs, says Horvath.

The new finding is a result of looking at which bits of DNA in cells have chemical tags called methyl groups added to them. These methyl groups get naturally added to or removed to alter the activity of genes, in what are known as epigenetic changes.

These methylation patterns vary greatly in different types of cells. However, in 2011, Horvath showed that in human blood cells, certain small bits of DNA accumulate methyl groups in a consistent way over time, and so can be used to roughly estimate a person's age.

In 2013, his team identified another "epigenetic clock" that signals the age of any human tissue, not just blood, suggesting there is an ageing process common to all human cells. The team has also identified "epigenetic clocks" for different species, such as elephants.

MANOJ SHAH/GETTY IMAGES

Rhinos are among the many mammals whose age can be estimated using DNA clocks

The latest clocks are based on studies of nearly 12,000 samples from 59 different tissue types across 185 species of mammal. This included several species each of lemurs, whales, goats, rhinos, bats, seals, kangaroos, wallabies, shrews and sloths, as well as the rock hyrax, Pacific walrus and platypus (bioRxiv, doi.org/jcn9).

"What we show is that there are these certain locations – genomic regions – that gain methylation in an extremely consistent way in all of these very different mammalian species," says Horvath.

Based on these regions, the team has developed three versions of the clock. One estimates an individual animal's age in years. Another estimates age relative to the maximum lifespan of the species, which can be converted into years if the maximum lifespan is known. Because the maximum lifespan isn't known for some species, the team also developed a third version that calculates age relative to that at which sexual maturity is reached.

The clocks are about 97 per cent accurate overall, but this varies from species to species. For bowhead whales, they were particularly poor, but this is probably because the existing method used to calculate the age of bowheads is inaccurate, says Horvath.

"The body's failure to switch off developmental processes that build our bodies is the key to ageing"

Because the clocks work in such a wide range of mammals, he thinks they will work for any mammal, not just the species in the study.

The team also did a number of other tests, showing, for instance, that the clocks run more slowly in mouse strains that are genetically engineered to live longer, and that they get set back to an earlier age when specialised cells are reprogrammed to turn them back into stem cells.

The work has impressed others in the field. "This is a really good study," says David Gems at University College London.

The findings run counter to the overriding thinking on what causes ageing. The dominant idea is that it is due to accumulation of damage, for example to DNA, such as that caused inside cells by highly reactive molecules known as free radicals. But Gems says the epigenetic clocks add to growing evidence for an alternative idea that he calls the programmatic theory.

The basic premise of this is that the body's failure to completely switch off the developmental processes that build our bodies is the key to ageing. For instance, pruning connections between neurons in the brain is a vital part of development when we are young, but might contribute to cognitive decline in later life.

"It doesn't argue that molecular damage plays no role in ageing, rather that ageing is largely caused by other things," says Gems.

Horvath found many of the sites that gain methylation tags with age are next to genes related to development. These results support the idea that ageing is linked to developmental processes common to all mammals – and probably all vertebrates, too, says Horvath.

"That, to me, is a smoking gun, that there are these processes that are conserved," he says. "There must be some sort of a program." ■

Physics

Einstein's gravity principle holds up after the most precise test yet

Karmela Padavic-Callaghan

THE most precise test yet of one of Albert Einstein's ideas about gravity has once again shown he was right. Physicists may need experiments that are even more accurate to figure out where his general theory of relativity breaks down and potential new forces and phenomena kick in.

"General relativity is a very good theory that works very well, but it doesn't explain all the observations in our universe," says Manuel Rodrigues at the French aerospace lab ONERA. Physicists have long looked for violations in general relativity that hint at phenomena missing from Einstein's theory, such as dark matter, and that could lead to a theory of gravity that includes quantum effects.

One area of focus is a pillar of general relativity called the weak equivalence principle. It states that all objects, regardless of their shape or material, fall with the same acceleration when gravity is the only force acting on them. It has been tested many times and has always held up.

Rodrigues and his colleagues launched a small satellite into space to test it with greater accuracy. On board were two devices known as electrostatic accelerometers that measure how objects experience gravity. Inside each device was a pair of nested cylinders. One device contained cylinders made of the same material and the other held cylinders of different materials. The weak equivalence principle says gravity should act the same on both regardless of these differences. However, if for some reason it didn't, the electrostatic accelerometers would pick it up.

A satellite experiment tested part of general relativity for 2.5 years

CNES

The experiment orbited 710 kilometres above Earth for two-and-a-half years, and didn't spot any gravitational differences. The set-up was sensitive enough to detect changes as small as a hundredth of a trillionth of a per cent, making it the most precise measurement of the weak equivalence principle ever carried out (*Physical Review Letters*, doi.org/jcpw).

Rodrigues says that the new measurement is 100 times more precise than previous tests, most of which were on Earth.

Philippe Bouyer at the French National Centre for Scientific Research says it will help justify future tests of fundamental physics theories in space. The project involved controlling a satellite extremely precisely and developing analysis techniques that account for even the smallest disturbances, such as friction between the satellite and space dust. It could become a foundation for future satellite-based experiments that are 10 or 100 times more precise, he says. He and his collaborators are planning such a mission that would use a quantum device instead of an electrostatic accelerometer.

Physicists will continue looking for violations of the equivalence principle, says Eric Adelberger at the University of Washington in Seattle. "There's more to physics than we understand, that's pretty clear. And this is a pretty likely place to look [for something new]." ▮

Medicine

Drug derived from tree sap could treat chronic wounds

AN antimicrobial drug derived from the sap of an Australian tree has shown promise for treating chronic wounds in animal tests.

Chronic wounds are common in people with diabetes, because poor circulation and other symptoms slow down healing. Such wounds are painful and have a high risk of infection.

Doctors increasingly want to curb the use of antibiotics in order to minimise the evolution of antibiotic-resistant bacteria. To look for alternatives, David Thomas at Cardiff University in the UK and his colleagues investigated compounds derived from the sap of the blushwood tree (*Fontainea picrosperma*), which grows in Australia.

They tested a gel containing a promising compound called EBC-1013 in two animals: mice used to model diabetes, with chronic wounds, and dairy calves. All dairy calves have their horns taken off, so the researchers applied the treatment to this wound.

In the calves treated with EBC-1013, 75 per cent of the wounds healed after 28 days, compared with just 25 per cent of untreated wounds. In the mice, complete wound healing was observed in five of the seven animals studied, whereas none of the seven wounds healed in the control group (*Science Translational Medicine*, doi.org/gqtds7).

Bacteria in chronic wounds are more likely to form a sticky mesh called a biofilm. These aggregations are resistant to antibiotics, making such wounds difficult to treat. The new drug appears to disrupt the structure of biofilms and induce the production of inflammatory cells and proteins that promote healing.

"The next challenge will be to show that these preclinical findings translate into the clinic"

"The next challenge will be to show that these preclinical findings translate into the clinic and that they can be developed into a safe and cost-effective treatment for chronic, non-healing wounds," says Matthew Hardman at the University of Hull, UK. ▮

Jason Arunn Murugesu

Briefing **Artificial intelligence**

Why are AIs creating scary images?

The continued production of the same few nightmarish characters is provoking urban myths, but there is a rational explanation, finds **Matthew Sparkes**

SOME artificial intelligences can generate realistic images from just a text prompt. These tools have been used to illustrate magazine covers and win art competitions, but they can also create strange results. Nightmarish creations have been consistently popping up recently, so what is going on?

What images are being generated?

One Twitter user asked an AI model now called Craiyon to generate images inspired by the word "crungus". The output was image after image of a snarling, hairy, goat-like man.

Next came Loab, a woman with dark hair, red cheeks and absent or disfigured eyes. In a series of images generated by an artist using an AI, Loab cropped up in ever more disturbing scenarios, but remained recognisable.

Are these characters discovered, invented or copied?

Some people have suggested – perhaps jokingly – that AI is simply revealing the existence of Crungus and Loab, and that the consistency of the images is proof they are real.

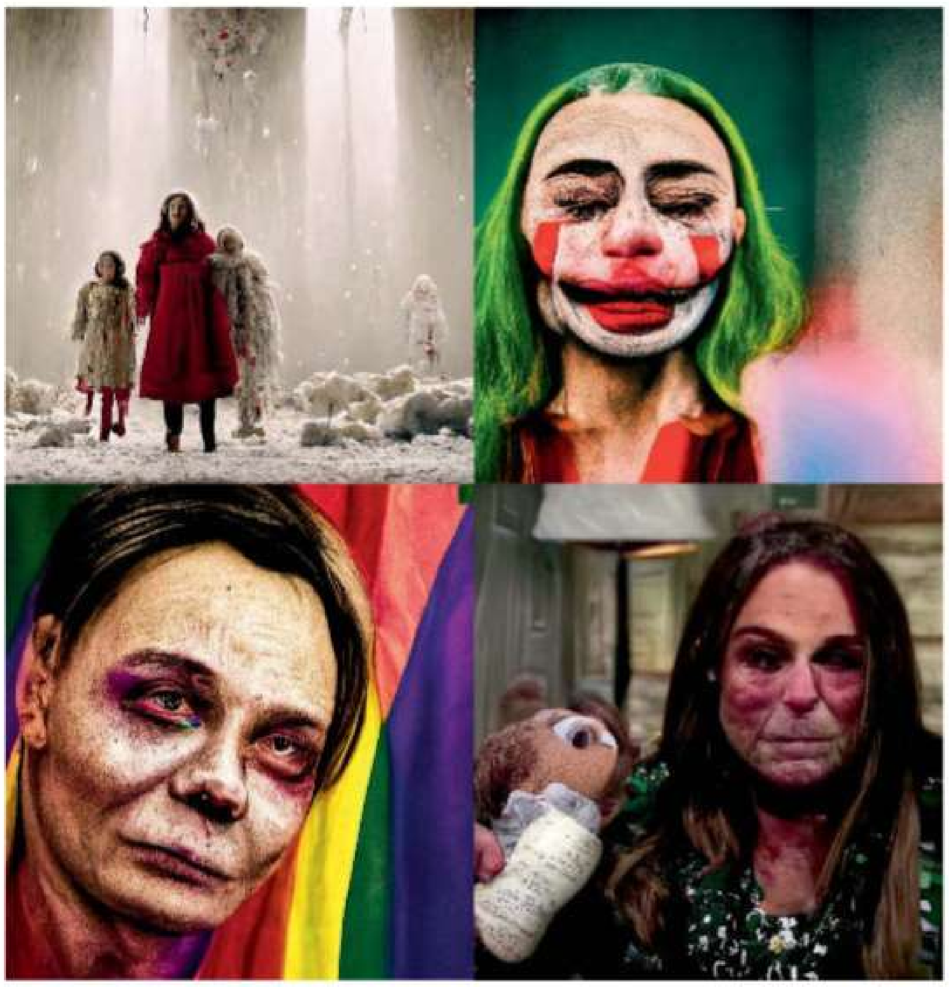
"What this actually shows are some of the limitations of AI image-generator models," says Mhairi Aitken at the Alan Turing Institute in London. Theories about creepy demons are likely to continue to spread via social media, she says, but the reality is more boring. The origins of these images lie in the reams of text, photos and other data created by humans, which is hoovered up by AIs in training, says Aitken.

Where did Crungus come from?

Comedian Guy Kelly, who generated the original images of Crungus, says he was trying to find made-up words that Craiyon could construct a clear image of.

"I thought it would be fun to plug a nonsense word into the AI bot to see if something that sounded like a concrete thing in my head gave consistent results. I had no idea what a Crungus would look like, just that it sounded a bit 'goblinny'," he says.

Although the AI's influences in creating Crungus could number in the thousands, there are a few that might be key. There is a range of games involving a character named Crungus and mentions of the word on Urban Dictionary dating back to 2018 relate to a monster that does "disgusting" things. The word also isn't dissimilar to Krampus – a creature said to punish naughty children at Christmas in some parts of Europe – and the appearance of the two creatures is also similar.



Loab, a character produced consistently by an AI image generator

SUPERCOMPOSITE/TWITTER

Mark Lee at the University of Birmingham, UK, says Crungus is just a composite of data Craiyon has seen. "I think we could say that it's producing things which are original," he says. "But they are based on previous examples. It could be just a blended image that's come from multiple sources. And it looks very scary, right?"

Where did Loab come from?

The artist Supercomposite, who generated Loab and asked to remain anonymous, told *New Scientist* that Loab was a result of time spent trawling the outputs of an unnamed AI for quirky results.

"It says a lot about what accidents are happening inside these neural networks, which are kind of black boxes," they say. "It's all based on images people have created and how people have decided to collect and curate the training data set. While it might seem like a ghost in the machine, it really just reflects our collective cultural output."

Loab was created with a "negatively weighted prompt", which, unlike a normal prompt, is an instruction to create an image that is conceptually as far from the input as possible. The results can be unpredictable.

> **"While it might seem like a ghost in the machine, it really just reflects our collective cultural output"**

Supercomposite asked the AI to create the opposite of "Brando", which gave a logo with the text "DIGITA PNTICS". They then asked for the opposite of that, and were given a series of images of Loab.

"Text prompts usually lead to a very wide set of outputs," says Aitken. "It may be that when a negative prompt is used, the resulting images are more constrained. That may explain why Loab appears so persistent."

What does this say about public understanding of AI?

Although we rely on AIs daily for things like voice assistants, not even the people developing them truly understand how they work. This is because AIs learn how to do things without us knowing how they do it. We just see an input and an output, the rest is hidden.

"AI is discussed as though it is somehow magical or mysterious," says Aitken. "This is probably the first of many examples which may well give birth to conspiracy theories or myths about characters living in cyberspace. These are simply computer programs, which only do what they are programmed to do, and that what they produce is a result of human ingenuity and imagination." ■

New Scientist Discovery Tours

29 November 2022

12 days for £5249 per person

The science of biodiversity: Costa Rica

Join author and broadcaster Gaia Vince (from Channel 4's *Escape to Costa Rica*) on an in-depth journey through this ecologically fascinating country.

Accompanied by local guides, naturalists and science author Gaia Vince, set out on an amazing expedition where you will experience wildlife first-hand and delve deep into the science behind biodiversity while enjoying the natural beauty of Costa Rica.

Discover cloud forests, wetlands, volcanic zones, primary rainforests and marine reserves in a country where conservation is baked into its legislation.

Staying in hotels and ecolodges embedded within the forests, you will experience cruises, walking safaris, treetop adventures, night walks and plenty of time for just relaxing surrounded by diverse flora and fauna.

Highlights

- Accompanied by author Gaia Vince. Led by local guides and naturalists.
- Guided and independent walks around several reserves and national parks.
- Night walks with experts in spotting nocturnal species.
- Exploring wetlands, rivers and marine ecosystems by boat.
- Ascending high into the forest canopies via the Sky Tram.
- Staying in hotels and ecolodges embedded within the forests.
- Learn about the history and culture of the capital San José.

Scan me to find out more

To book, call
UK +44 (0) 203 3089 917
(UK office hours: Mon-Fri 9am to 5:30pm, Sat 10am to 4:30pm)
Or email newscientist@intrepidtravel.com

In partnership with Intrepid Travel

Intrepid

ABTA
Travel with confidence
ABTA No.88888

Environment

Bangalore floods highlight how cities must adapt to climate change

Lou Del Bello

BANGALORE is slowly recovering after large areas of the Indian city were drenched by exceptionally heavy monsoon rains earlier this month. Last week, boats and tractors could be seen carrying commuters to work on the flooded roads of the Karnataka state capital, while hundreds of families had to be evacuated.

Experts say the floods were exacerbated by poor urban planning, highlighting how cities in India and elsewhere need to adapt as climate change brings more extreme rainfall in the future.

More than 120 of the 210 artificial lakes in the city have overflowed this month, fuelled by precipitation that is 206 per cent higher than average in the southern part of the state. Such heavy rainfall events are predicted to occur more frequently in southern India with global warming.

Bangalore, an IT hub, has 99 automatic weather stations that have been collecting data for the past 10 years, says Vishwanath Srikantaiah, a civil engineer and water expert who helped design water management policies in the city. "The results confirm that rainfall intensity is going up, but also that rainfall patterns vary across the city," he says. This is because Bangalore's expansion has contributed to the urban heat island effect in which cities retain more heat, altering the local microclimate and, in turn, the strategies needed to manage it.

"Bangalore wallows in nostalgia – we talk of our old water systems and we believe if they were protected, that alone would prevent flooding," says Srikantaiah. But the existing system was designed to trap water for irrigation. For example, Bangalore's lakes aren't equipped with sluice gates, which means they can't release excess water and their water level cannot be lowered in anticipation of rain.

A flooded street in Bangalore, India, on 6 September

JAGADEESH NV/EPA-EFE/SHUTTERSTOCK

"We now have to invest in infrastructure appropriate for these very intense rains, such as improved sewerage, storm water drainage and solid waste management," he says. This would ensure debris isn't washed away by floodwater, clogging drains.

As well as safely removing excess storm water, urban planners envisage a "sponge city" able to store it for when drought comes. "The climate crisis also means that this year we could have too much rain, and next year too little," says Srikantaiah.

Cities around the world must plan for different types of climate hazards, including heatwaves and droughts, at the same time, says Hannah Cloke at the University of Reading in the UK. "We can't assume that what we've seen in the last 20 years in our cities will stay the same," she says.

However, a radical overhaul of urban infrastructure is unattainable for many cities, particularly in low-income countries. In these places, says Cloke, "the low hanging fruit are early-warning systems: being able to tell people that something is going to happen and for the authorities in charge to evacuate people when needed." ▮

Astronomy

Weird brown dwarf seen blasting off its outer layers

A STRANGE "failed star" has shed its outer layers – an event that astronomers had never seen before. It appears to be surrounded by a gas bubble that was mostly blasted off by an immense pulse of heat.

Dary Ruíz-Rodríguez at the National Radio Astronomy Observatory in Virginia and her team were looking for early signs of planets forming when they spotted what seemed to be a bubble of carbon monoxide. "When I found this object it was so different I thought maybe I did something wrong," says Ruíz-Rodríguez.

Further observations revealed it was a brown dwarf more than 50 times the mass of Jupiter, about 150 light years away. Brown dwarfs are far larger than gas giants like Jupiter, but not quite large enough to fuse hydrogen atoms into helium in their cores like stars. The veil of carbon monoxide around this brown dwarf was unusual though, as was its anomalous brightness.

When some stars begin to fuse helium, they undergo a huge burst of energy called a thermal pulse, which travels outwards through the star like an expanding fireball and blows off its outer layers. A similar phenomenon may be going on here.

"It's like a brown dwarf with some personality problems," says Ruíz-Rodríguez. "Sometimes it behaves like a planet, sometimes it behaves like a star, and in this case it's behaving more like a star."

Models showed that the brown dwarf most likely began to fuse deuterium – a heavy form of hydrogen – at its centre, creating a thermal pulse (arXiv, doi.org/jcpj). Deuterium is easier to ignite than hydrogen, and young brown dwarfs are expected to do so briefly. The process is poorly understood, as highlighted by the fact that this is the first report of a gas bubble like this around a brown dwarf.

"It's like a brown dwarf with some personality problems. It's behaving more like a star"

Archival data on about 1000 other brown dwarfs turned up two that appeared to resemble this one, so these types of brown dwarfs are probably extremely uncommon. ▮

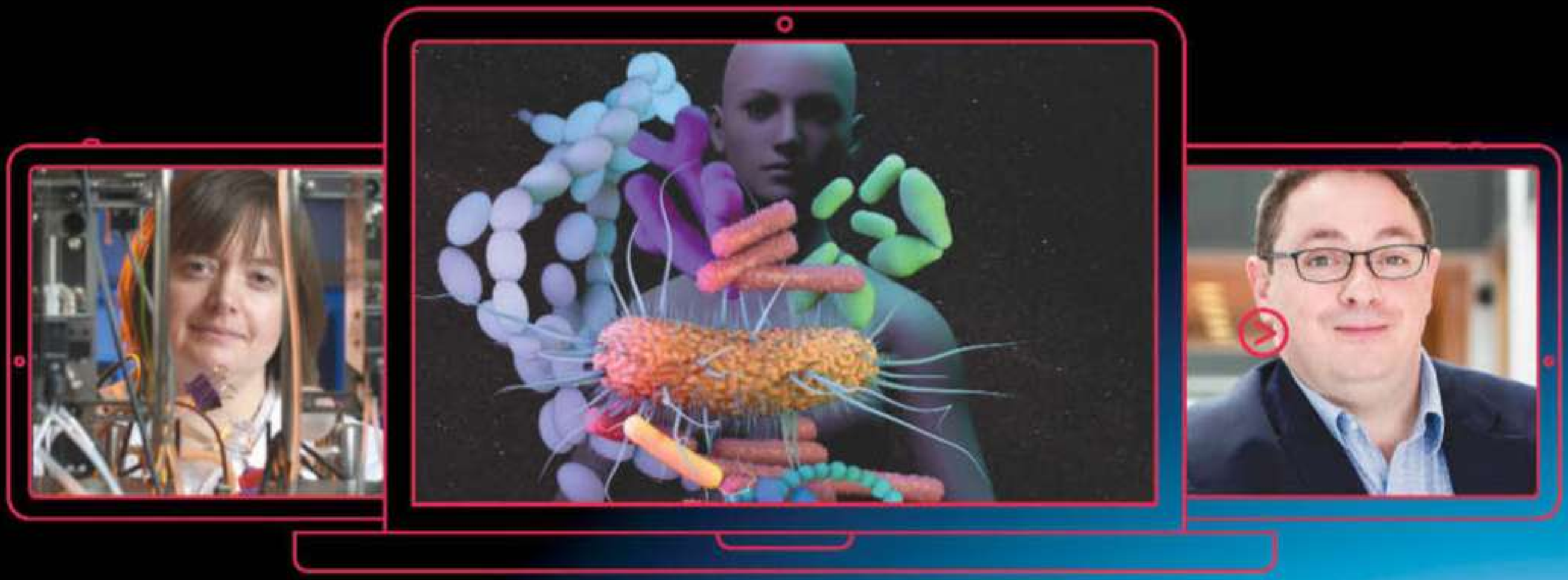
Leah Crane

New
Scientist
Academy

ONLINE
COURSE

YOUR
SECOND
BRAIN

What’s happening in your gut can determine how you feel and behave. Find out why – and how to take control.



The gut microbiome is more powerful than we’d ever imagined, impacting our feelings and behaviour. Our course reveals all at **newscientist.com/yourmicrobiome**

Solar system

Rings of Saturn may be remains of moon

SATURN'S rings look like they could be the result of a moon that was ripped apart.

Simulations by Jack Wisdom at the Massachusetts Institute of Technology and his colleagues used data from the Cassini spacecraft. They show that an additional moon between Titan and Iapetus, destroyed between 100 million and 200 million years ago, could explain both of these features (*Science*, doi.org/gqtd8r).

If the extra satellite was destroyed, the debris left behind could have become Saturn's rings, leading the researchers to name this wrecked moon Chrysalis after the form a caterpillar takes as it transforms into a butterfly. "This was just a small moon made of ice and then the rings suddenly emerged when it was ripped apart," says Wisdom. **Leah Crane**

Archaeology

Keeping of livestock predates farming

SOME hunter-gatherers probably kept sheep, or possibly gazelles, outside their huts before they started farming crops, according to traces of ancient animal dung.

Alexia Smith at the University of Connecticut and her team have found spherulites – tiny spheres of calcium found primarily in the faeces of grass-eating ruminants like cattle, sheep and antelopes – outside groups of huts that belonged to humans who lived more than 12,000 years ago in what is now Syria.

They also found charred spherulites in fireplaces, indicating burning of dung (*PLoS One*, doi.org/gqs78h). "They're still hunters and gatherers, and they're still relying on hunted gazelle, but now they're starting to bring live animals to the site and keep them for however long they need them," says Smith.
Christa Lesté-Lasserre

PIKSELSTOCK/SHUTTERSTOCK

Parenting

Walking with a crying baby is best way to get it to sleep

SCIENTISTS have found the most effective method to soothe a crying baby: walk around with it.

"This finding makes sense because when most people pick up a crying baby, they rarely just stand still with them, they instinctively walk around," says Harriet Hiscock at the Royal Children's Hospital in Melbourne, Australia.

Kumi Kuroda at the RIKEN Center for Brain Science in Japan and her team got interested in how babies respond to motion after studying the "transport response" in other mammals, in which infants become passive and their heart rates slow when their mothers carry them.

To test this in people, the team monitored 21 crying babies in Japan and Italy, either at home or in the lab, while their mothers tried four ways to calm them for 5 minutes: holding their baby while walking, rocking them in a pram or rocking cot, holding them while seated and laying them down in a cot.

The babies didn't calm down when held by a seated mother or placed in a cot. But when their mothers walked around with them, they all stopped crying and nearly half fell asleep within 5 minutes (*Current Biology*, doi.org/gqs2rx).

Rocking them in a pram or cot had a similar calming effect, but to a lesser extent. Heart monitors showed that, like other infant mammals, the babies' heart rates slowed when carried. Preliminary experiments show the same effect when fathers walk with babies.

The team advises caregivers who use this walking technique to hold their baby for another 5 to 8 minutes after they fall asleep before putting them in a cot, as the infants in the study tended to wake if they were transferred earlier. **Alice Klein**

Really brief

SHUTTERSTOCK/DR MORLEY READ

Best camouflage mimics objects

Predators take longer to find prey that uses what is known as masquerade camouflage to resemble inanimate objects like rocks, sticks, leaves or dung than they do animals that use other camouflage strategies, such as chaotic colour patterns (*Proceedings of the Royal Society B: Biological Sciences*, doi.org/gqs7mx).

Weird diamonds found in meteorites

Diamonds thought to be from destroyed dwarf planets have been found in meteorites in Africa. Like Earth diamonds, they are made of carbon, but their atoms form a hexagonal structure rather than a cubic one, so they are predicted to be 60 per cent harder (*PNAS*, doi.org/jckp).

Bluer streetlights may be health risk

Photos taken by crew on the International Space Station reveal that street lighting is getting brighter and bluer in many countries in Europe. That may interfere with sleep and cause other health issues. The shift is due to greater use of energy efficient LEDs (*Science Advances*, doi.org/jckn).

JOIN US AT

THE WORLD'S GREATEST FESTIVAL OF IDEAS & DISCOVERIES

New Scientist Live
EARLY BIRD TICKET DISCOUNT ENDS 25 SEPT

FEATURE PARTNERS

SCHOOLS' DAY SPONSOR

MEDIA PARTNER

CHARITY PARTNER

newscientist.com/ns0710

MARTIN DAVIES
HEAD OF EVENT PRODUCTION

12 TALKS NOT TO MISS!

New Scientist Live: London is back for 2022 and I can't wait for the doors to ExCeL London to open and the buzz of thousands of science fans having the time of their lives to return.

This year, the show will run from 7-9 October, with Friday 7 October just for schools. We've got some of the best-loved names in British science, from Turi King to Adam Rutherford, alongside up-and-coming researchers who are tackling some of humanity's greatest challenges. You can hear about everything from the biggest number in the world to the smallest particles in the universe from experts at the forefront of scientific discovery.

Don't live near London? Don't panic! We'll be streaming every stage live for online ticket holders, and you can catch up on talks you might have missed on our new online platform.

Our Engage Stage will once again feature the amazing Space Shed. Be sure to drop in for fireside chats, speaker Q&As and out-of-this-world fun.

We've got four main stages covering the biggest questions in science. You can explore the secrets of the cosmos on the Universe Stage, the mysteries of being human on the Mind and Body Stage, the wonders of nature on the Our Planet Stage and the science of tomorrow on the Future Stage.

Our packed show-floor has amazing exhibits where you can get hands on with the latest science and innovations. From piloting a virtual drone to a VR rollercoaster, get interactive with a host of leading-edge organisations showcasing their game-changing technologies.

Our dedicated day just for schools on Friday 7 October will be packed with amazing talks, from esports to explosions. Check out our website if you want to bring your school along.

Whether you're a veteran of past shows or you're joining us for the first time, I strongly believe science is for everyone and everyone is welcome at the world's greatest festival of ideas and discovery. I can't wait to see you there.

Check out the full programme at newscientist.com/ns0710

SATURDAY
8 OCTOBER

MIND AND BODY STAGE

THE DARK HISTORY AND TROUBLING PRESENT OF EUGENICS

Adam Rutherford will tell the story of attempts by the powerful throughout history to dictate reproduction and regulate the interface of breeding and society.

OUR PLANET STAGE

AN OCEAN OF SALT

Helen Czerski will explore the great stories of our ocean told through salt.

UNIVERSE STAGE

THE HIDDEN UNIVERSE

Emma Osborne will take you on a gravitational wave journey from creation to detection, and the discoveries that reveal the hidden universe.

OUR PLANET STAGE

WONDERDOG

Jules Howard will investigate the amazing history of dog cognition science.

UNIVERSE STAGE

BLACK HOLES

Jeff Forshaw will reveal the complex quantum problems that emerge when trying to track information flowing in and out of black holes.

FUTURE STAGE

THE BIGGEST NUMBER IN THE WORLD

Join **Agnijo Banerjee** on an epic quest for unfathomably large numbers, revealing the answers to questions like: are there more grains of sand on Earth or stars in the universe?

SUNDAY
9 OCTOBER

MIND AND BODY STAGE

ULTRA-PROCESSED FOOD

Join **Chris** and **Xand van Tulleken** for the truth about what ultra-processed foods do to our bodies.

FUTURE STAGE

THE FUTURE OF UK SCIENCE AND INNOVATION

Join **Sir Patrick Vallance** as he outlines the case for why science in government matters, his role during the covid-19 pandemic and the lessons British science can take forward.

UNIVERSE STAGE

A NEW FORCE OF NATURE?

Harry Cliff will reveal the growing evidence from collisions at the Large Hadron Collider and the Muon g-2 experiment at Fermilab of a new force of nature.

FUTURE STAGE

THE GEOLOGICAL RECORD OF CLIMATE CHANGE

Chris Jackson will look at the geological record of climate change, how these changes impacted life on Earth, and how this can help us better understand our present and future climate.

MIND AND BODY STAGE

DNA FAMILY SECRETS

Turi King will chart the rise in the use of DNA in genealogy and forensics for everything from tracing long-lost family members to catching criminals.

OUR PLANET STAGE

NEANDERTHALS: EXPLORING COMPLEX MINDS

Rebecca Wragg Sykes will explore the complex cognition of Neanderthals, and reveal the latest data and theories about why, and how, they disappeared.

ON THE SHOW-FLOOR

New Scientist Live is more than just talks! On our gigantic show-floor we've got stands showcasing the latest research and technology, interactive experiences for the whole family and a lively Market Place to get your hands on the best scientific swag.

How will your visit to the doctor change in the next 50 years? Join a wealth of medical experts from King's College London as they showcase leading-edge technology that will power the hospitals of tomorrow.

EXPERIENCE THE FUTURE

Visit the Discovery Tours stand to experience the "smell of space" and be taken on a journey beyond Earth by sampling odours that scientists, and Apollo and ISS astronauts, have learned about by studying and exploring the solar system.

COME AND SMELL SPACE

NEGLECTED TROPICAL DISEASES AND WHERE TO FIND THEM

We've all become familiar with viruses over the past few years, but what about parasites? Join leading neglected tropical disease experts from the University of Glasgow as they showcase how research in the field, in the lab and in the clinic is combating these fascinating but destructive organisms.

VIRTUAL REALITY ROLLERCOASTER RIDES

Immerse yourself in the most realistic 3D rollercoaster ride imaginable. There's something for everyone, from the "scream buster" rides for the adventurous to something more sedate for those who prefer a calmer experience.

WATCHING ONLINE? YOU CAN STILL BE PART OF THE FUN

For the first time in London, we will be streaming all stages live to online ticket holders. Sit back and enjoy presentations from the finest minds in science or get interactive and join the chat, to connect with your fellow viewers across the globe and send your questions to be answered live on stage.

See the whole range of activities and book your tickets now at newscientist.com/ns0710

The columnist
What makes a species new? **Penny Sarchet** weighs in p26

Aperture
Astronomy Photographer of the Year winners p28

Letters
More good reasons to stop burning wood at home p30

Culture
David Attenborough impresses again in *Frozen Planet II* p32

Culture columnist
Sally Adee on the virtues of fantasy in sci-fi p34

Comment

Apes, not angels

If we want to change our consumerist society, we need greener status signals that appeal to our animal instincts, says **Solitaire Townsend**

TAYLOR SWIFT often tops the charts, but her most recent number one has drawn more censure than acclaim. Because, at 8293 tonnes of carbon emitted so far this year, she has been judged the world's most polluting celebrity in terms of private jet use – easily beating Kylie Jenner, who infamously took a 17-minute flight in hers.

For many of my fellow environmentalists, this carbon-spurting excess reinforces disgust at our celebrity-obsessed, conspicuous-consuming culture. The only thing that will save the world from a greed-triggered apocalypse? Sweeping it all away.

This is a tempting idea, but it has one major snag: when environmentalists exhort us to care less about buying cars and clothes, and instead base our lifestyle choices on the planet's limited resources, they ignore an elemental part of our hominid nature: preoccupation with status.

SIMONE ROTELLA

Status is, of course, the key that unlocks every animal's ultimate goal – breeding rights. Charles Darwin named the status displays rife in nature "honest signalling", noting that male peacocks' ostentatious feathers prove to females that they are so adept at finding food and avoiding predators they can afford to grow big, bright, utterly wasteful plumage. Some deer grow antlers so unwieldy that they become caught in trees for days. Other animals buy jewellery and fast cars. From the forest to the penthouse, all status signals say: "I am successful enough to have more than I need. See my superior genes!"

If wasteful excess is entirely natural, it poses a head-scratcher for environmentalism. We eco-activists emphasise that humans aren't above nature. But we can't have it both ways. If people are no better than any other mammal, how can we banish our natural instincts for status?

This paradox needs untangling, and fast, because massive social and behavioural change has moved centre stage in our struggle to meet the Paris climate agreement.

According to a report by the Intergovernmental Panel on Climate Change, sociocultural change could rapidly save 5 per cent of demand-side carbon. But I fear this gigatonne-level prize could remain unclaimed unless we embrace the realities of being great apes and forget exhortations to act like angels.

Rather than trying to conquer our evolved desire for status, we must switch the symbols used to display it. Luckily, status semiotics are malleable. Throughout history, humans have been wildly creative with ours, from foot-binding in late imperial China to poorer Victorians blackening their teeth with boot polish as only the rich could afford enamel-rotting sugar.

Society is ripe for sustainable status signals. According to a recent eBay report, 52 per cent of UK citizens feel guilty when buying unsustainable products – rising to 71 per cent among young people. And we are all more likely to purchase greener products when we are watched. Perhaps upcycled or rented clothes could carry a distinctive tag that makes sustainability a status display. Maybe travelling by train could earn covetable passport stamps.

That said, it is in virtual worlds where status symbols have the greatest potential to radically cut material consumption. Your online status and virtual possessions could become more important than anything you own in the real world. That might not sound appealing, but status displays must remain anxiety-inducing, hierarchical and unfair – because that is the point of them.

By shifting from high-carbon, disposable, heavily material symbols to virtual, reusable and sustainable ones, we might buy more time to solve climate change. And if a bunch of great apes can decouple social status from its material impacts, we might just have the effect of angels. ▮

Solitaire Townsend is chief solutionist at Futerra and author of *The Happy Hero*

Wild Wild Life

Define 'new' Even at this time of rapid extinction, there are many species to be discovered, but we need to take care over what we mean when referring to "new species", says **Penny Sarchet**

Penny Sarchet is *New Scientist*'s news and digital director. She is a former plant scientist and a lifelong birdwatcher. You can sign up to her free monthly newsletter at newscientist.com/wildwildlife

Penny's week

What I'm reading
Wild Fell *by Lee Schofield, an absorbing account of fighting for nature in the Lake District*

What I'm watching
Gardeners' World*, to make sure I don't miss any important garden tasks this autumn*

What I'm working on
A different kind of taxonomy: overhauling how we organise all the articles on newscientist.com

ONE thing I will admit to being quite pedantic about in my job as an editor is policing the use of the phrase "new species". It isn't because I don't like the concept – there are few things I find more exciting than a newly described organism we didn't know about before. It is because there are so many ways to interpret – and misinterpret – the idea of a new species. But rather than this being a thorny issue worth avoiding, it is actually a fun mess of a problem that takes us to the core of many interesting issues in biology.

What is a species? The most familiar definition is that it is a group of individuals that can produce fertile offspring through reproduction. It feels correct to many – a blackbird can breed with another blackbird and produce young blackbirds that are able themselves to make more blackbirds. But this definition is no use for a wide range of species, such as plants or animals that clone themselves rather than reproducing sexually, or organisms that freely hybridise with many other species. And if breeding success is the way you assess if something is a species, it is impossible to apply the concept to fossils of extinct organisms.

There may be as many as 33 other definitions of what a species is, and you can see the sense in many of them. The morphological species concept, that a species is a group of organisms that look consistently distinct, just feels right on some level – but stumbles when species develop regional variations in colour or pattern yet still fundamentally seem to be the same organism.

A genetic definition suggests a species is a group of individuals that can reproduce and that have a distinct genetic profile. With the onset of DNA sequencing in recent decades, the genetic definition has opened the door to many more "new" species being recognised.

It would be easy to jump to the conclusion that DNA analysis provides us with too many "new" species to be useful, especially if they all look much the same as organisms we already knew about. But this isn't always the case.

Often, undescribed species are hiding in plain sight. Take a giant isopod living in an aquarium in Japan. As we reported in our 20 August issue, it had been mistaken for another species, until genetic analysis revealed it was distinct. Upon closer inspection, researchers realised it had extra-long antennae and a yellower shell.

> **"Often, undescribed species are hiding in plain sight, like a giant isopod that had been mistaken for another species"**

One reason it is hard to settle on a single definition for a species is because we now know the old methods for classifying organisms – into kingdoms, phyla, classes, orders, families, genera and species – don't perfectly reflect reality. There is no reason why, for example, canids (the dog family) and rosaceae (the rose family) should each naturally subdivide in the same way. Are genera of the rose family as equally different from each other as genera in the dog family?

A more accurate, more modern approach is to think about clades – a clade is a group of organisms that are more related to each other than they are to anything outside the clade. Clades are nested within clades, on and on. Some contain huge numbers of organisms, some contain very few. Some evolved much earlier than others, and they can't all be arranged symmetrically on levels of equivalence. It is a much better reflection of reality and helps us think about how life forms evolve, but for many practical purposes, it isn't that useful.

When assessing the biodiversity of an area, for example, it can be useful to catalogue how many families or species there are – even if the distinction between each taxonomic level is a bit arbitrary. Unlike the impossible task of counting every clade, it is a practical process that provides useful information.

So, while "species" isn't a perfect concept, it is an extremely useful one – helping us to catalogue roughly 1.6 million different life forms on our planet. And even at this time of heart-breakingly rapid extinctions, there are many more species yet to be discovered if we can get to them in time. One estimate suggests there are about 7 million unknown species out there, and another that there could be more than 9000 unknown species of trees alone. It is easy to find countless examples in recent publications, including multiple new species of moths, hermit crabs and magnolias.

Then why be so pedantic? Because, while I am comfortable with there being multiple definitions of a species, I am less comfortable with ambiguity in language. When we say "new species", do we mean it is a new product of evolution? Or a newly discovered species? And is it really new to all of humanity, or perhaps just to scientists or Westerners?

So language matters. But what could be more fascinating than learning of yet another species, however it is defined? ▮

Up next week:
Chanda Prescod-Weinstein

9 out of 10 customers recommend Symprove

Live bacteria for gut support

Come and meet us at New Scientist Live

Gluten free Vegan Dairy free

★ Trustpilot
★★★★★

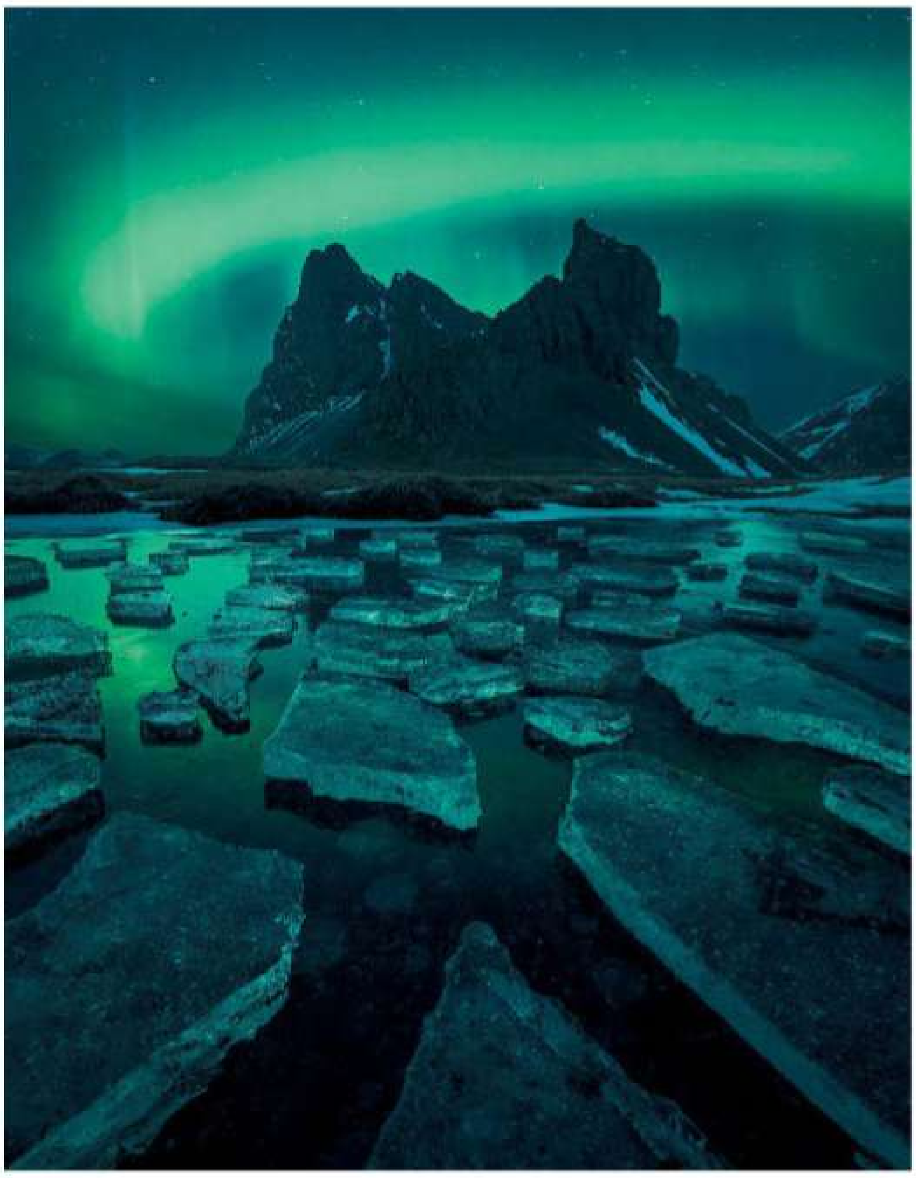
What's unique about Symprove?

- **Highly researched** combination of unique bacteria strains
- **Alive and active** for immediate action
- **Water-based** so does not trigger digestion
- **Recommended by thousands** of doctors, dietitians and scientists

For more information please visit: **www.symprove.com**

SYMPROVE™

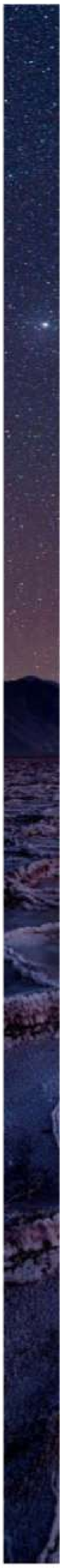
Come and talk all things gut health and try our new flavour at Stand A10.



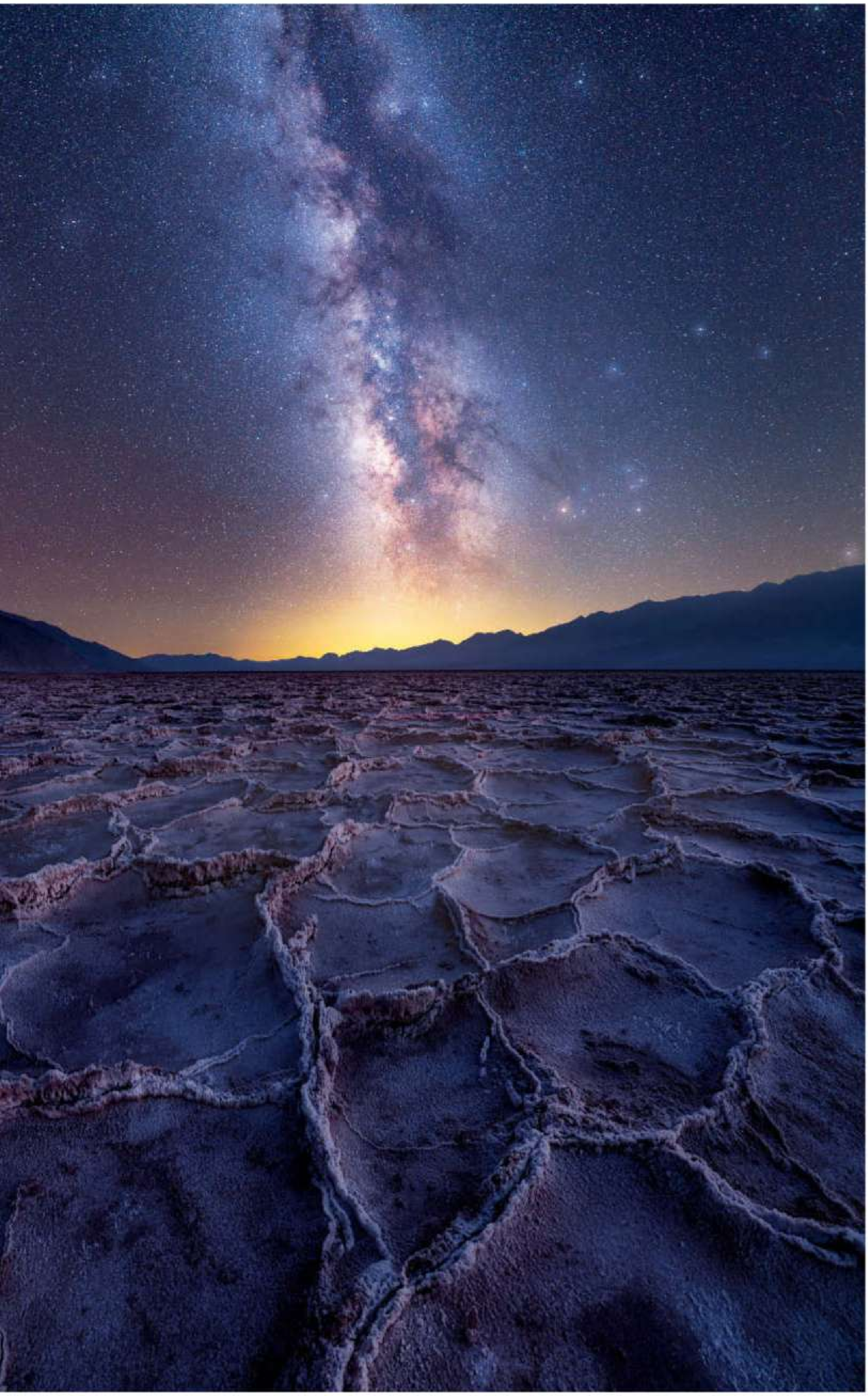
IN THE EMBRACE OF A GREEN LADY © FILIP HREBENDA

THE NIGHT HIGHWAY © FILIP HREBENDA

STABBING INTO THE STARS © ZIHUI HU



BADWATER MILKY WAY © ABHIJIT PATIL



Looking up

Photographers **Filip Hrebenda, Zihui Hu, Abhijit Patil**

THESE spellbinding photos reveal what is lying in wait when we cast our gaze upwards to the vast expanse of space. The images are some of the winning and shortlisted entries for this year's Astronomy Photographer of the Year competition, organised by the Royal Observatory in London.

Filip Hrebenda won the Aurorae category with *In the Embrace of a Green Lady* (top left), showing the emerald hues of the northern lights, or aurora borealis, reflected on a frozen lake in Iceland. Green is the most common colour seen in the northern lights. It is caused when oxygen atoms in the atmosphere between 120 and 180 kilometres above Earth's surface decay to their normal energy state, after being excited by solar wind.

The remaining images are from the Skyscapes category, with Zihui Hu taking the top prize with a shot of the snow-capped Namcha Barwa mountain in Tibet (bottom left), titled *Stabbing Into the Stars* – a nod to the mountain's name, which means "spear thrusting into the sky" in Tibetan. The stars appear as trails in the sky thanks to long-exposure photography.

Death Valley in California features in runner-up Abhijit Patil's image, *Badwater Milky Way* (main image), revealing the characteristic hexagonal mud patterns in the valley's Badwater basin.

Another of Hrebenda's images, *The Night Highway* (top, centre), captures the rare sight of both the Milky Way and an aurora over the Vestrahorn mountain in Iceland and was highly commended.

The winning photos are on display at an exhibition at the National Maritime Museum in London, UK, until 13 August 2023.

Gege Li

Editor's pick

More good reasons to stop burning wood at home

10 September, p 8

From Graham Jones, Bridgham, Norfolk, UK

You report a rush to buy firewood in the UK amid rapidly rising gas prices, and highlight the pollution that will result from burning more wood.

There is another issue: the relatively poor overall efficiency of wood-burning stoves. The wood needs to be dried and transported to the user, which takes energy. The stove itself takes time to start and can't be shut down at will, so may generate more heat than is required. A gas-fired stove doesn't suffer from these disadvantages.

Wood can be anaerobically processed in a slurry digester to generate methane, and there is already a gas distribution mechanism that makes gas available to users, at least in cities and towns. If firewood is to be used, surely it should be in this way?

Hormone replacement therapy isn't for everyone

3 September, p 38

From Caroline Smith, Bonnybridge, Falkirk, UK

Caroline Williams raises some interesting points on taking hormone replacement therapy to reduce the negative impacts of the menopause, but doesn't mention the difficult situation faced by the substantial minority of women who have had breast cancer.

Current estimates suggest that there are 600,000 such women in the UK alone, who have specific risks associated with taking HRT due to their diagnosis.

Saving Earth must be top priority for one and all

10 September, p 27

From Fabio Galantini, Cambridge, UK

It was a pleasure to read William MacAskill's article "Planning ahead", which reminds us that we don't just inherit Earth from our ancestors, but are its stewards for our descendants. I content myself with wanting to leave somewhere behind where my children will be able to thrive, without looking thousands of years ahead, but the sentiment is the same.

The piece came soon after the UK's *Daily Telegraph* gave its view: "Saving the planet is a laudable aim, but the costs of doing so have to be set against other essential priorities." Words fail me.

We can't have our AI cake and eat it too

10 September, p 47

From Perry Bebbington, Kimberley, Nottinghamshire, UK

Much has been said about bias in decisions made by AI and the need to make it neutral and "fair". In your interview with Paolo Benanti, he brings up the call to get women and children onto the lifeboats of the Titanic first, and suggests that AI should follow an ethical rule he calls "the quality of gentleness". This directly contradicts the attempts to remove biases from AI. We can't have it both ways.

A little bit of latitude in health advice is needed

10 September, p 28

From Carmel McNaught, Melbourne, Australia

One of the main problems with so much health advice, including that based on BMI, is that it is too absolute, too definite. Advice on body weight, the recommended number of alcoholic drinks, the number of steps to walk and so on is rarely given as a range.

Why don't we see standard deviations or some other measure of variation with each of these numbers? There is a huge amount of variation in humans, and this needs to be explicitly recognised.

From Sam Newman, London, UK

Consuming fewer calories than are burned each day will cause weight loss. Unfortunately, too many people eat more than they need, and excess food production has major environmental impacts. Perhaps there is merit in an environmental tax that could deter this? That will motivate the curbing of appetites.

Fears of the death of plastic may be a little premature

Letters, 20 August

From Gerben Wierda, Heerlen, The Netherlands

Alec Williams fears that microbes genetically engineered to eat plastic waste might come to consume useful plastics. This echoes the 1970s novel *Mutant 59: The Plastic Eaters*. The risk is all too real, but the catastrophe might be slowed by the fact that there are many different types of plastic. In addition, the proposed sea-dwelling plastic-eating microorganisms won't become land or air dwellers all that easily.

Radiation is a lesser worry for astronauts

Letters, 10 September

From Matthew Adams, Cambridge, UK

Bryn Glover questions the European and Russian space agencies designating a 1-sievert dose of radiation as acceptable for astronauts, which is estimated to equate to an average 5 per cent rise in cancer fatality risk.

Given the total number of astronauts and the number who have died in testing, on the launchpad or during a mission, the rise in risk of a poor cancer outcome in later life would seem insignificant by comparison with the risks from sitting in a capsule on top of a massive load of fuel. Even as it becomes "routine" to send people to the International Space Station and on future lunar missions, they remain very brave.

Super batteries will need a super grid to charge them

10 September, p 38

From Richard Glover, London, UK

Several of your recent articles have mentioned battery types in development that could be charged quicker than previous systems – for example, quantum batteries. This would be very useful for electric vehicles, for instance. But all that stored energy has to come from somewhere.

Fast charging means a high charging current. Without plenty of capacity and suitable infrastructure, it will be difficult to take advantage of these advanced electrical storage systems.

Water meters may not be the drought fix you think

20 August, p 9

From David Stott, Gawsworth, Cheshire, UK

In the story "England faces a drier future", it was observed that households with water meters use 24 per cent less water than those without. You seem to imply that having a meter lowers usage. I suspect the causality is the other way around. Since water meters are optional, what households might elect to have one installed? Ones already with low usage. It certainly saved me money.

For the record

In our look at remastered NASA images (10 September, p 30), Rusty Schweickart was in a photo of the Apollo 9 mission and the Apollo 8 astronaut was Bill Anders.

Want to get in touch?

Send letters to letters@newscientist.com; see terms at newscientist.com/letters

Letters sent to New Scientist, Northcliffe House, 2 Derry Street, London W8 5TT will be delayed

New Scientist
Jobs

Recruit the brightest minds in science

At New Scientist Jobs, we can help you to reach, engage and attract the highest-quality job applicants, wherever they are. Over 157,000 people* come to our site every month looking for their dream job and ideal employer – which could be you!

newscientistjobs.com

*Source: Google Analysis Jan-Dec 2021

Attenborough, still the best

David Attenborough's wonderful *Frozen Planet II* reminds us of what we risk losing – and outclasses two new nature series in the process, says **Josh Bell**

TV

Frozen Planet II
BBC One
Airing weekly until 16 October

Epic Adventures With Bertie Gregory
Disney+
Streaming now

Super/Natural
Disney+
Streaming now

WHEN it comes to nature documentaries, there is David Attenborough, and then there is everyone else. The veteran BBC broadcaster has been making films and series about the natural world for 70 years, and shows no indication of wrapping up.

Attenborough's latest for the BBC, *Frozen Planet II*, is a sequel to his *Frozen Planet* series, which focused on life in the Antarctic and the Arctic. This time, he also explores frigid regions, including the Gobi desert and Siberian boreal forests, with the emphasis on how climate change threatens them.

Attenborough introduces the characteristically dazzling footage of animals from the BBC Studios Natural History Unit by inviting viewers to "witness their wonders while there is still time to save them", and the spectre of global warming hangs over every moment of the opening episode.

He starts in familiar territory, the Antarctic, with emperor penguins, the cute creatures whose 2005 mega-hit *March of the Penguins* brought nature documentaries to a new audience. It is a perfect way to ease into Attenborough's urgent message.

The series traverses the distance between the poles in a single episode that starts in the Antarctic and ends in the Arctic, moving from brief glimpses of the Andes to the Himalayas and the vast Eurasian Steppe, where Attenborough showcases another cute star, the Pallas's cat.

SNORRI THOR/BBC STUDIOS

***Frozen Planet II*'s team filmed inside a mountain glacier in Iceland**

Throughout the one episode available for review, he alternates between soothing descriptions of animal behaviour and a newer, more desperate plea to save the habitats these creatures rely on. Attenborough even appears on screen, still full of the passion and curiosity he has brought to his nature documentary work.

Two new National Geographic series on Disney+ are no match for Attenborough, although one of them is explicitly positioned to launch another international nature documentary star.

Epic Adventures With Bertie Gregory features the BAFTA-winning wildlife cinematographer as he works capturing amazing animal images, although the most common image is Gregory himself. The first episode opens on him complaining about the need to charge the battery in his drone, and that sets the tone for a series that focuses on film-making, rather than the film itself.

Gregory shares Attenborough's curiosity about the natural world, but he is otherwise a very modern TV star, comfortable on screen and ready to make every discovery and experience about himself. Behind-the-scenes footage has been a staple of nature documentaries for years, and it can be fascinating to see the effort that goes into securing the awe-inspiring shots of swooping aerial predators or swarming sea life that viewers may sometimes take for granted.

NATIONAL GEOGRAPHIC FOR DISNEY+/ROBIN COX

Water anoles can trap air in order to breathe under water

In the five-episode series, Gregory places himself close to the animals he is documenting, sometimes taking risks, such as swimming alongside tiger sharks to land the perfect shot. His dedication and enthusiasm are clear, and, like Attenborough, he emphasises the potentially devastating effects of climate change on the ecosystems.

But *Epic Adventures With Bertie Gregory* often feels more like a candid reality show than a nature documentary. Gregory highlights artificial-sounding deadlines his team faces to score footage of a particular phenomenon, but the suspense is contrived. As they prepare, it can seem like an ad for Gregory's latest camera kit.

When he stops chattering and turns the camera away from himself, his footage is often breathtaking. He is clearly a talented cinematographer, which is what got him such a high-profile gig, and the series delivers images of dolphins and eagles rivalling anything in *Frozen Planet II*. It is too bad they last only a few seconds before Gregory inserts himself back into the frame.

There is a much bigger star at the helm of *Super/Natural*, but he stays off screen. Actor Benedict Cumberbatch narrates the show, which is executive produced by director James Cameron and harnesses his interest in cutting-edge tech to illustrate natural phenomena in a new way.

A disclaimer notes that "some sequences have been graphically enhanced", and indeed there are moments in *Super/Natural* that look a bit like special effects demos. That is all in service of depicting extraordinary animal abilities, which the series treats with the kind of bombast usually reserved for superheroes.

The makers of *Super/Natural* are less concerned with activism than Attenborough or Gregory, and they even include segments that place positive spins on human disruption of animal spaces. Still, any documentary that makes animals look as amazing as water anoles, some species of which create an air bubble to breathe underwater, is clearly advocating their survival.

> **"Gregory places himself close to the animals he is documenting, taking risks like swimming alongside tiger sharks"**

Its tone is one of wonder and excitement. "If you think you know nature, think again" is the cheesy tag line Cumberbatch intones at the start and end of each episode. But there is something endearing about a show that uses sophisticated special effects to depict the dissemination of hamster pheromones or to highlight the ultraviolet glow of flying squirrels.

Even Attenborough isn't immune to tech, touting the use of racer drones in the first episode of *Frozen Planet II*. Nature documentaries have taken huge strides since he started out, many of them due to Attenborough himself. If *Epic Adventures With Bertie Gregory* and *Super/Natural* are the next evolutionary step, at least they have the original around to remind them how it is done.

Josh Bell is a writer based in Las Vegas

A Grimm future

An exquisite new sci-fi movie has a dark, fairy-tale edge, finds **Davide Abbatescianni**

Film

Vesper

Directed by Kristina Buožytė and Bruno Samper

General release in US cinemas; UK cinemas to be announced

IFC FILMS

Vesper (Raffiella Chapman) struggles to survive on an Earth with a ruined ecosystem

FOR a good example of what European science fiction has to offer, you need look no further than *Vesper*, a beautifully crafted film that premiered at the Czech Republic's Karlovy Vary film festival in July.

It is set in a dystopian world where Earth's ecosystems have totally collapsed as a result of an unspecified catastrophe. Many people now have disabilities and live in medieval-looking villages, where violence is spread and encouraged.

At the centre of the story is 13-year-old Vesper (Raffiella Chapman), who is struggling to survive. Her father Darius (Richard Brake) is paralysed, but he can accompany Vesper everywhere via a drone that is a vessel for his mind and voice.

Vesper meets a mysterious young woman, Camellia (Rosy McEwen), who fled from the Citadel, a secluded community where people lead comfortable, pre-disaster lives. With Camellia's help, Vesper plans to leave for the Citadel in search of a cure for her father. Meanwhile Darius's brother Jonas (Eddie Marsan) does his best to ruin her plans.

Even though *Vesper* draws heavily on tropes from sci-fi classics, such as *Children of Men* and *The Hunger Games*, this co-production pulls them together in a wholly distinct way. The two directors create a *Grimms' Fairy Tales* atmosphere, with archetypal characters and a linear narrative that contributes to an overall feeling of unease.

Visually, the film astonishes, as art director Raimondas Dičius and production designer Ramūnas Rastauskas craft a universe where remnants of the natural world coexist with basic tech and biohacking. And cinematographer Feliksas Abrukauskas creates gorgeous interiors, recalling masterworks by 17th-century Dutch painters with beautiful chiaroscuro effects.

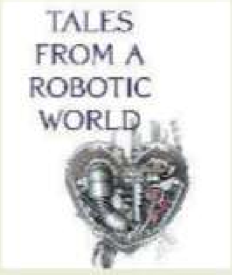
***Vesper* is timely, with direct and indirect nods to climate change: one of its most powerful scenes is a reminder not to take the natural beauty we still enjoy for granted. Reading an old book full of marvellous creatures that once inhabited Earth – cats, owls, parrots and wolves – Vesper and Camellia mimic their calls in a moment of sheer joy and amazement.**

Davide Abbatescianni is a film critic based in Rome

Don't miss

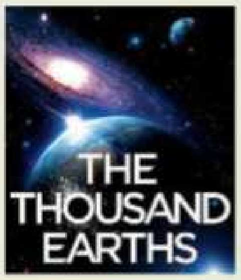
Watch

Galwad is a week-long mix of live performance and multimedia. Telling the time-travelling story of Efa (Alexandria Riley, above), it ends with a live broadcast and a drama set in Wales in 2052. See the finale on Sky Arts on 2 October.



Read

Tales from a Robotic World by Dario Floreano and Nicola Nosengo mixes speculation, fact and fiction to create a future where robotic tech brings love, companionship and well-organised traffic to the world. On sale from 27 September.



Read

The Thousand Earths by Stephen Baxter dovetails the story of Mela, facing the end of her world as its seas rise unstoppably, with that of Hackett, on a mission of exploration and maybe, just maybe, salvation. On sale 29 September.

TOP: KIRSTEN MCTERNAN

The sci-fi column

Fantasy rules

Bliss Montage and *Expect Me Tomorrow* are blends of sci-fi and grown-up fantasy that give a shot in the arm to help us face seemingly hopeless causes with a fresh perspective. How else will we find energy to act, asks **Sally Adee**

Sally Adee is a technology and science writer based in London. Follow her on Twitter @sally_adee

Books

Bliss Montage
Ling Ma
Text Publishing

Expect Me Tomorrow
Christopher Priest
Gollancz

Sally also recommends...

Book

Mindwalker
Kate Dylan
Hodder & Stoughton

Dylan has said she hoped to create a young adult Marvel superhero story. In addition to this, and being a fantasy, Mindwalker *is a data protection cautionary tale wrapped inside a teen romance adventure with megacorps, technological mind control and revolutionaries. If you are a young person or you have one living in your house, this should be on your shelf.*

COKADA/GETTY IMAGES

Real glaciology is at the core of Christopher Priest's climate fantasy

IN LING MA'S *Bliss Montage*, the discomforts that define everyday reality are stretched and deformed until they detonate like a balloon that has been twisted too tightly.

Ma, whose 2018 novel, *Severance*, won the Kirkus Prize for Fiction, uses short stories to work through the barbed scenarios in her latest book. These include a frenemy so diabolical she can make you disappear, a woman who marries for financial security but finds that her husband can literally only speak in "$$$", and a professor mired in academia's tedium and backbiting who finds a hidden door behind a filing cabinet.

Ma's book can be eaten in one gulp. This is partly because the stories are so fluidly written, partly because they are connected, but maybe most importantly because they draw on the tropes of fantasy.

All of this applies to Christopher Priest's *Expect Me Tomorrow*, too. After a summer of unprecedented evidence of global heating in many parts of the world, his new book feels like a cool rain shower.

It is set half in the 19th century, half in 2050, and uses real findings from glaciology to link the times. Priest reinforces these parallels by populating both story arcs with twin protagonists: the 19th-century Beck twins and the Ramsey twins in the 21st century. Then there is the matter of setting up a literal "neural link" between these pairs of characters.

> "Fantasy imbues readers with a sense that not everything is known, that we might still find cause for hope"

What makes Priest's fantastical tale so provocative is that a lot of it has some basis in reality. There was a real Adolf Beck, who was jailed for fraud in the 1890s, and some of the other 19th-century characters did study facets of an already changing climate, such as the Gulf Stream and glaciers.

Most of the predictions in the 2050 half of the book are based on the same models that inspired David Wallace-Wells's book, *The Uninhabitable Earth*, which is prominent in Priest's bibliography.

But the sly parallels between the 19th century and what happens in the 2050s might land Priest in hot water. His book veers perilously close to some of the perennial talking points that dodge human responsibility for climate change, such as the role of solar cycles, volcanoes and the rest.

In fact, Priest uses these plot points for a wholly different purpose. We must be extremely clear: he doesn't contend that human-made climate change is false. The fantasy he builds doesn't insult climate science at all; it just opens new doors to reimagining its outcome. And this is what climate fiction needs today, more than another nihilistic screed or terrifying scenario.

Right now, something about the way we think has ossified. We seem to have agreed that the climate is doomed and every year will be hotter until we all die. Once a narrative acquires the status of received wisdom, it can be difficult to see beyond it or even around it. What if we could shake ourselves out of this "doomerist" trance that has taken hold?

Risky as it is, Priest's gambit almost feels like a public service. Fantasy is the defining genre of our time, wrote James Marriott in a recent article in *The Times*: "Fantasy answers a peculiar modern need – for history perhaps, or for an alternative reality invested with profounder significances than our own." I would add that it imbues readers with a sense that not everything can be known, that we might still be surprised or find cause for hope.

How else are we going to get up the energy to do anything about climate change? ▮

New Scientist
Events

SAVE 33% WITH A SERIES TICKET*

ONLINE EVENT
BIG THINKERS SERIES

SEAN CARROLL
SPACE, TIME AND MOTION

Thursday 20 October 2022,
6-7pm BST, 1-2pm EDT and on demand

Where, when and how? are some of the most fundamental questions we can ask, and knowledge of space, time and motion has been central to the biggest discoveries in physics.

Join professor of theoretical physics, Sean Carroll as he explores deep questions about the nature of space, time and change, laying out the framework of classical physics from Galileo and Euclid to Newton and Einstein. Starting with ideas that are centuries old, Sean will be your guide to the equations that revolutionised physics, leading to the theory of relativity and the prediction of black holes.

Find out more and book your ticket
newscientist.com/spaceandmotion

ALSO IN THE SERIES

THE ORIGIN OF THE UNIVERSE
WILL KINNEY
REALITY+: FROM THE MATRIX TO THE METAVERSE
DAVID CHALMERS
WHAT WE DON'T KNOW ABOUT GRAVITY
CLAUDIA DE RHAM
PHYSICS AT THE END OF THE UNIVERSE
KATIE MACK
A BRIEF HISTORY OF TIMEKEEPING
CHAD ORZEL
FANTASTIC NUMBERS AND WHERE TO FIND THEM
TONY PADILLA
MEMORY, THE BRAIN AND WHO WE ARE
VERONICA O'KEANE

*saving based on individual ticket prices.

BIG THINKERS SERIES
SEAN CARROLL

Lucky you

Who you are is down to genes and environment, but also a third, overlooked, factor: chance. That changes everything, finds **Clare Wilson**

SHUTTERSTOCK/JIRI HERA

BATMAN became a vigilante after seeing his parents murdered. Wonder Woman's crime-fighting abilities are thanks to her supernatural creation and childhood of athletic training. Many of us mortals have origin stories too, albeit less dramatic ones. You may feel, for instance, you have inherited cleverness from your mother or confidence from your father, or a love of cooking from fun times in the kitchen with grandparents.

One of the most fascinating questions about what makes us the way we are is how much of our personalities, abilities and interests is down to our genes and how much to our early environment – nature or nurture. But there is a third influence that has, until recently, gone under the radar: randomness. Specifically, chance events that affect nerve cells as the brain is developing. That is a colossal oversight. The latest research suggests that the role of this randomness in shaping who we are could be far greater than environmental factors, and in some cases as much as genetic ones. If so, we should really see ourselves as the product of nature, nurture and "noise".

This isn't just of interest to neuroscientists: it has profound implications for us all. We could stop fretting quite so much about our parenting choices and – sorry, Freud – we may also have to allocate less blame to our own parents for how we have turned out. "We have a tendency to develop narrative explanations for differences we see in people," says Benjamin de Bivort at Harvard University. "The deeper I've gotten into this work, the more I've come to think: maybe it's just a fluke."

Questions about the relative importance of our innate nature and upbringing go way back, even featuring in debates between the Greek philosopher Plato and his pupil Aristotle. But the catchy phrase "nature versus nurture" came from 19th-century scientist Francis Galton, a pioneer in the emerging field of heredity. Galton also popularised eugenics, the repugnant idea that some people with "undesirable" traits should be stopped from having children.

"We should see ourselves as the product of nature, nurture and noise"

Modern scientists still struggle to dissociate the field of behavioural genetics from its shameful past, but they have made progress in measuring the relative impacts of genes and environment on traits such as intelligence, introversion and self-control. Nature and nurture are often hard to untangle because children in the same families tend to share both DNA and the way they were raised. For instance, if children who are read to as babies tend to do well at school, that could be because early exposure to books fuels their interest in learning or because they have inherited bookish genes from their parents.

Geneticists have addressed this problem using two kinds of studies. The first involves comparing identical twins with non-identical twins. The former share pretty much all of their DNA, the latter share only half, but both are assumed to share their upbringing to a similar extent. The second sort of study compares pairs of biological siblings with pairs of siblings in which one child was adopted into the family at birth. Both types of pairs tend to have similar upbringings, but the biological siblings share half their DNA, whereas the adoptive ones share none.

Several decades of these kinds of studies, involving hundreds or even thousands of participants, have generated a broad consensus: of the influences that we can measure, genes do most of the work. The exact figure varies depending on the trait – happiness, resilience, or whatever – but DNA often accounts for about half of the difference between individuals. The effects of upbringing, on the other hand, are much smaller, ranging from 17 per cent to as little as 0 per cent. "In adoption studies, correlations between characteristics of families and adopted children are basically zero," says Eric Turkheimer at the University of Virginia. A notable exception is intelligence, where the impact of upbringing is around 25 per cent during childhood. However, this dwindles to almost nothing in adulthood, when any effects from hothouse schooling or pushy parenting fade and people have much more control

Join us at New Scientist Live
Discover what makes us human at the Mind and Body Stage
newscientistlive.com

over their intellectual lives. There is also a caveat – in cases of childhood abuse, the environmental impacts can have large and lasting effects. “Clearly, if you lock a child in a closet, they’re going to be damaged,” says geneticist Robert Plomin at King’s College London, who wrote about these findings in his 2018 book *Blueprint: How DNA makes us who we are*. “But we are talking about why children in the normal population with normal upbringings are different [from one another].”

Despite the compelling evidence, the idea that parenting has little lasting influence on the intelligence and personality of offspring isn’t widely accepted outside the field of behavioural genetics. One reason is its social and political associations: not only the stain left by eugenics, but also because, today, many on the right of the political spectrum see some of society’s ills as rooted in human genetics. This can sometimes lead their opponents on the left to reject the findings of studies showing that genes are so influential. Another problem is that there are many studies claiming to find large effects of early environment on life outcomes. However, any such research that doesn’t use the twin or adoptive sibling methods to tease out the contributions of genes is flawed.

Even reputable research papers may use language that confuses the issue. If a study finds, for instance, that genes account for half of the variation in IQ between adults, researchers often report they have found that genes do 50 per cent of the work, and “the environment” does the rest. They are using “environment” to mean anything that isn’t genes. Sometimes, they even stress this so-called environmental contribution to show that they don’t believe we are slaves to our genes, says Kevin Mitchell, a neurogeneticist at Trinity College Dublin. “It’s like a cover for those who think [genetics] has dark connotations.”

Things become clearer when researchers divide these non-genetic factors into two types: “shared environment” and “non-shared environment”. The former refers to the environment children in the same family have in common – covering everything we would normally think of as upbringing, such as parenting style, family income, type of schooling and so on. This is what the twin and adoption studies have found lies between

Roots of randomness

Who you are depends on your genes and on the environment in which you grew up. However, evidence from several kinds of research suggests that “noise” – random events during brain development – also plays a role in shaping each of us (see main story). What could those events be?

Nine-banded armadillos (*Dasypus novemcinctus*) can provide some answers because they are born in litters of identical quadruplets. Even though members of a quad are genetic clones, from early on in life they may differ slightly in features such as tameness or how many scales make up their bands, says Jesse Gillis at the University of Toronto in Canada.

Within each quad, about one-tenth of the differences in which genes are turned on or off in their white blood cells – used as a handy proxy for total variation – stems from random “silencing” of some of their genes caused by chemical changes to their DNA. This seems to happen when the embryos are balls of just a few hundred cells, Gillis’s team has calculated.

WIRING UP

Random factors also influence another key stage in embryonic development, when immature brain cells produce projections, called axons, that probe their way through the brain to make connections with other neurons.

These outgrowths are attracted to nearby chemical cues, in the same way that microscopic animals hunt down food, so it seems plausible that chance variations in the distribution of these chemicals in the embryonic brain could affect the final wiring diagram. In flies, at least, such variation “can lead to large changes in the configuration of those cells”, says Benjamin de Bivort at Harvard University.

Developing human brains are much harder to peer into. Nevertheless, geneticists have found that chance mutations that happen as immature brain cells multiply during embryonic development are among the many factors linked with schizophrenia and autism.

Both are now seen not as all-or-nothing states, but as one end of a spectrum of mental characteristics. The same chance mutations linked with schizophrenia and autism could also play a role in personality differences in the rest of the population.

NICK DAVID/GETTY IMAGES

Nature and nurture alone may not explain your social skills

NEIL BROMHALL/SCIENCE PHOTO LIBRARY

Chance events affect the developing brain of a fetus in the womb

17 and 0 per cent. If genes account for around 50 per cent of our variation, simple maths tells us that between 33 and 50 per cent is down to something else – the unhelpfully named non-shared environment. What this actually consists of remains mysterious and yet, going by the maths, its impact overshadows that of upbringing and sometimes equals the effects of genes. You could call this the dark matter of our personal origin stories.

What kind of influences might the dark matter consist of? For a long time, behavioural geneticists assumed it comprised many small factors, apparently too trivial to be measurable or even memorable. This could include things like chance encounters with teachers or friends, minor childhood illnesses or early romantic relationships. Plomin's colleague at King's College London, Damien Morris, gives a hypothetical example of a pair of identical twins sitting next to each other in school. "One stares out the window and is distracted by a bird flying by, just as the other twin is enraptured by the teacher's account of a particular poem – and it forms a lifelong love of poetry," he says.

But animal researchers have been finding growing evidence that at least some of the chance influences that shape us could happen as a result of random events that occur in the brain before birth. This may clash with some people's understanding of how brains are made. DNA is often described as the body's blueprint, as it is in the title of Plomin's book. This makes it sound like genes encode a precise wiring diagram for the estimated 86 billion human brain cells and their 1000 trillion connections, known as synapses. But that isn't the case. The genes involved in brain development are more like a recipe for making a cake, albeit one where each instruction has a degree of vagueness. At each new step – for instance, when embryonic brain cells multiply, migrate to new locations or specialise as different cell types – cells that do things one way in an individual do them to a slightly greater or lesser extent in another genetically identical person.

> **"You could call this other influence the dark matter of our personal origin stories"**

"We all start with our individual genome, then development is the unfolding of the organism based on the information in that genome, but it adds its own variation as it goes along," says Mitchell. Or, as he puts it in his 2018 book, *Innate: How the wiring of our brains shapes who we are*: "You can't bake the same cake twice."

We can't observe this unfolding in human fetuses because the method currently used for visualising the brain's wiring diagram destroys it in the process. It is also highly laborious, requiring brain tissue to be turned into thousands of ultrathin slices, so has mainly been used to study animals with very small brains, like worms and fruit flies, as well as parts of the mouse brain.

But the initial findings from these studies show that genetically identical animals raised in conditions that are as similar as possible can have slightly different brain wiring. For instance, research by de Bivort and his colleagues found that fruit flies have an innate, long-lasting preference for turning to the left or right while walking around, which is controlled by the wiring pattern of brain cells called columnar neurons. He and his team discovered that fly offspring didn't inherit this tendency from their parents, and that the variability was even present in a group of genetically identical flies. This, they conclude, suggests the cause was intrinsic random events. In 2020, another group of researchers found that differences in brain wiring result in random variation in the degree to which flies are attracted to high-contrast stripe patterns.

The tiny brains of flies, like those of most animals, are broadly symmetrical, so another strategy is to look at differences between the left and right sides. With this approach, it is even more likely that any differences arise due to chance, as the two sides have been built by the same set of genes and exposed to the same environment. Researchers are increasingly finding that there can be asymmetry between the two sides at the level of individual brain cells. For instance, when it comes to projection neurons – a type of brain cell involved in › smell – either side of the brain can have two, three or four of them.

It is unimaginable to do these sorts of experiments in people, but our shared biology with flies suggests there would be parallels. "Things you find in flies at the molecular level tend to be present in humans at the molecular level," says de Bivort. What's more, although we can't yet visualise the brain-wiring diagrams of larger creatures, looking at their behaviour tells us that genetically identical animals can differ in traits, like innate aggression and exploratory behaviour. This has been shown in mice, crayfish and armadillos, and may become more widely appreciated thanks to the growing industry of pet cloning. Earlier this year came news of a woman from Texas who paid $25,000 to have her beloved cat cloned after it died and found that, although the new pet looked just like her old one, it had quite a different personality.

Upbringing, including schooling, has only a small impact on how we turn out

LIAM NORRIS/CULTURA CREATIVE LTD/ALAMY

The mechanisms underpinning these chance events in brain development are only just starting to emerge (see "Roots of randomness", page 38). It also remains unclear when the crucial events occur. Some human geneticists believe that, in people, they are more likely to happen during childhood rather than when they are in the womb. This thinking is based on twin studies that find the impact of non-shared environment varies over childhood. For example, if the IQ of identical twins is measured, one might test higher than the other at a young age, but a few years later the difference may be absent, or even reversed. "If developmental noise [in the womb] accounted for the non-shared environment – because some had their neurons zig in an intelligence-enhancing direction, and others had them zag in the other direction – most of it would be persistent," says Morris.

Random brain-wiring events might even be shaping who we are well beyond childhood. Neuroscientists used to think that the human brain finishes maturing in the first few years of life, but more recent brain-scanning work shows that it continues to develop throughout adolescence and even into early adulthood. Many key regions of teenage brains undergo a process called "pruning", or loss of brain cell connections. This is usually assumed to be a directed response to their environment – but, in truth, we know very little about the mechanisms and causes of pruning. So it is possible that random events play at least some role.

Whenever the random events happen, they will, by their very nature, be hard to study. De Bivort hopes more insights will come from studies of "mini-brains", tiny balls of neural tissue grown in the lab that replicate some aspects of fetal brain structure. Genetically identical human mini-brains could be grown under the same culture conditions and then sliced up to discern their wiring diagrams. Alternatively, if more powerful yet non-destructive brain-scanning techniques become available one day, they could be used on newborn identical twins to look at structural differences between the neuronal networks in their brains.

For some of the postulated "noise", it is debatable if it stems from truly random events, as physicists would define them, or is just unmeasurable, but Plomin says that doesn't matter. "From a practical point of view, a lot of the differences in our behaviour are essentially unpredictable," he says.

"Random brain-wiring events might be shaping us well beyond childhood"

This new way of understanding brain development may split opinions. It might be resisted by the psychoanalysis industry, whose practitioners are renowned for saying to their clients: "Tell me about your childhood." Certainly, the idea that our psyche is profoundly affected by how we are raised is deeply rooted in culture, from works of fiction to parenting advice books. If random events really do trump parental influence, that seems to negate one of the English language's best-known modern poems, Philip Larkin's *This Be the Verse*, which begins: "They fuck you up, your mum and dad." But the influence of chance may come as no surprise to parents who see clear differences in their children's personalities despite their best attempts at equal treatment.

For now, much about these random influences remains mysterious. The question marks behind such a formative force on the human psyche might, for some, be a source of existential angst. But to others, it is liberating. "We have been so locked into genes versus environment being the only sources of variation, when, in fact, these idiosyncratic trajectories are what make us unique and unrepeatable," says Mitchell. "There's something sort of life-affirming about that." ▮

Clare Wilson is a medical news reporter at *New Scientist*

NABIL NEZZAR

"Space and time emerge from something deeper"

If black holes consume everything in their vicinity and then slowly die, what happens to the stuff that falls in? As particle physicists **Brian Cox** and **Jeff Forshaw** tell Abigail Beall, answers to this black hole information paradox are revealing the universe at its most fundamental

A BLACK hole is a region of space so dense that nothing, not even light, can move quickly enough to escape. At least that was the thinking until the 1970s, when Stephen Hawking calculated that black holes aren't completely black after all. Instead, Hawking argued, they slowly give off radiation – now known as Hawking radiation – that eventually means the black hole will evaporate.

Hawking's calculations created a problem. Quantum theory says information can never vanish, so what happens to the information that has fallen into the black hole? Where does it go? This is the black hole information paradox. It has troubled physicists for decades because it highlights the profound disconnect between general relativity, Albert Einstein's theory of gravity from which black holes were summoned, and the laws of quantum theory that govern the subatomic realm.

Now, we seem to be on the cusp of a resolution to this, with huge consequences for how we understand the cosmos at its most fundamental. All of which is the subject of a forthcoming book called *Black Holes: The key to understanding the universe* by Jeff Forshaw and Brian Cox, both particle physicists at the University of Manchester, UK.

New Scientist spoke to them about the latest thinking on the black hole information paradox, what it reveals about where space-time comes from and why the deep structure of the universe looks surprisingly similar to a quantum computer.

Abigail Beall: When most people think of black holes, they probably think of big things in space like collapsing stars and huge forces of gravity. Why are black holes important to particle physicists?

Jeff Forshaw: Black holes are places where quantum physics and general relativity are both relevant and yet we can't describe, in a consistent way, what happens when black holes evaporate. So, something has got to give. Either quantum mechanics or general relativity is wrong.

Brian Cox: A key point, as well, is that this clash between quantum mechanics and general relativity happens in the vicinity of the event horizon of a black hole, the boundary beyond which light cannot escape. It's been known for a long time that you would need quantum gravity to explain what happens at a singularity, the point deep inside a black hole where the curvature of space-time becomes so ludicrously extreme and gravity so strong that the equations of general relativity break down. Everything you calculate just goes to infinity.

The real treasure here, though, is that the clash comes in a region where you can't just throw your hands up and say "it's something to do with the singularity, so just forget about it". It's a region where gravity is not ludicrously strong, so we don't expect to need quantum gravity.

When he first highlighted this clash, Hawking went against quantum theory by suggesting that radiation escapes from a black hole and that the information it carries disappears. What do we mean by information here?

JF: Imagine everything that falls into a black hole. You could describe it with a long binary sequence of ones and zeros, or bits. And if you've got an algorithm that decodes that, it'll tell you what fell in. The information is the smallest binary string of bits that is sufficient to completely tell you about the thing that fell in, whether it's a book or a bunch of quantum bits or, you know, a star collapsing.

BC: This is determinism, which is central to physics. If you know everything about a system at one point, then you can predict what it's going to do in the future and what it was doing in the past.

So what happens to the information when radiation escapes a black hole?

BC: If information is preserved, then, in principle, you could collect all the Hawking radiation and process it in some way. You could wind time back to reconstruct what kind of star collapsed to form the black hole, for example. But that did not appear to be the case because, in Hawking's original calculation, there is no information in the radiation at all.

JF: The Hawking calculation said that there's no algorithm that could possibly extract any message from that radiation. That was Hawking's original calculation – that information is obliterated in a black hole, which violates a key property of quantum mechanics – that information is conserved, and suggests that quantum theory is wrong.

NASA/CXC/M. WEISS

NewScientistLive

Jeff Forshaw will be speaking about the black hole information paradox at New Scientist Live on 8 October. Join us at the world's greatest festival of science at ExCeL London between 7 and 9 October and online

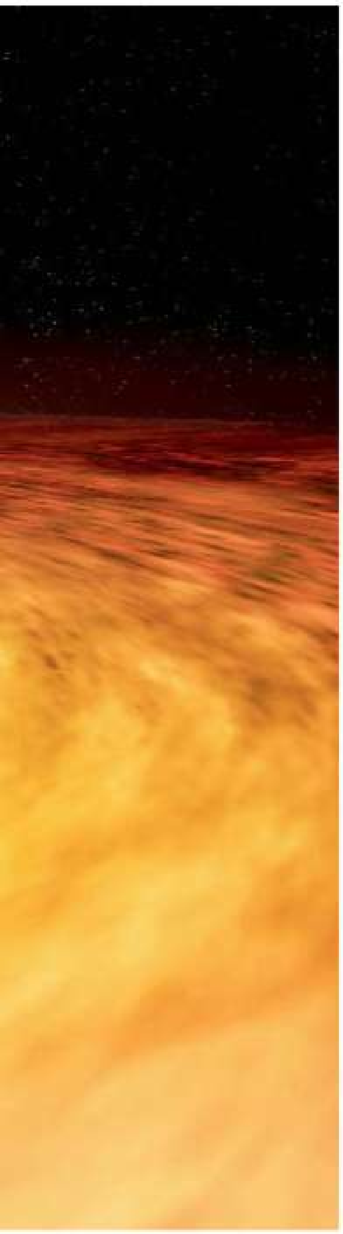
newscientistlive.com

But not everyone agreed with Hawking. What happened?

JF: The theorists Gerard 't Hooft and Leonard Susskind said: "Well, let's suppose that the information does come out and quantum mechanics is good." Then you've got a real problem. The information is coming out from the black hole, but things fall through the horizon of a black hole into the singularity. There's no mechanism to get anything from the singularity back out again.

What they realised is that, from the point of view of somebody always outside of the black hole, nothing ever actually falls through the horizon. Everything freezes on it, in the sense that it stops. Actually, it's a very hot membrane and anything that falls on it kind of evaporates off.

If I throw a book into a black hole, from my external perspective, it gets obliterated and burned up and spread all over the horizon of the black hole, then comes back out as Hawking radiation. The book's kind of burned up on the horizon. But from the point of view of the book, it just falls through the horizon. We could be falling through the horizon of a black hole now, it's a totally benign experience.



An artist's impression of a star spiralling towards a black hole's event horizon, beyond which light is unable to escape

So does the book fall in or does it stay on the horizon?
JF: What 't Hooft and Susskind said is that, actually, both happen. This is what is called black hole complementarity. It's the idea that information simultaneously gets reflected off the black hole and falls smoothly through that horizon.
BC: They're two perfectly legitimate views of the same thing. Now, modern calculations are showing that this picture is largely correct. Both are legitimate views. Immediately, you can see that challenges our notion of what reality is. How can something have two apparently different fates?

So what actually happens to the information, and what does that tell us about reality?
JF: The first thing you might think would be that the information gets copied on the horizon, so there are two versions. But again, that's not allowed in quantum mechanics. That pushed 't Hooft and Susskind into this idea of holography. They supposed that the information in any region of space is encoded on the boundary of that region of space. Key to this is quantum entanglement, a very non-intuitive connection that can be created between two of more particles. If you cut out a little chunk of space, then the entanglement with the rest of the universe would be sufficient to completely encode for what's happening inside that region.

Later, Juan Maldacena at the Institute for Advanced Study in Princeton discovered that a particular region of space-time has a completely equivalent description on the boundary of that space-time in terms of a quantum field theory, which describes the movements of subatomic particles. Think of it like the surface of a ball that encodes for general relativity in the interior. In one description of what's happening, there is no interior space, it is just the surface. That is also an explicit demonstration of the ideas that 't Hooft and Susskind brought forward with complementarity. You've got the interior space being encoded on the boundary, rather like the information inside of a black hole being encoded on its horizon.

All of which suggests space-time is emergent, but what is it emerging from, exactly, and how?
JF: It's become clear over the past decade that entanglement is a key feature. Basically, think of the surface of the ball as lots of entangled particles. For every entangled link, think of a little quantum wormhole. There's a correspondence between entanglement and wormholes – it is as if many-particle entanglement can be thought of in terms of a network of wormholes that weave space-time.
BC: We're discovering a deeper structure, which doesn't have space and time in it. And you might say: "Which one is the real description, then? Is it the thing on the boundary or the space inside?" As far as I'm aware, nobody really gets into that discussion. These are equivalent descriptions of the physics.

Who are we to say which is a deeper picture? It's tempting to do so because it is true that if you look at the temperature of a box full of gas, then you can say that emerges from a description of atoms. I think you would be correct to say the temperature, pressure and entropy – or measure of disorder – of a box of gas has got a deeper description, in terms of moving parts. It becomes philosophical quite quickly. But one super-cool thing is how all this relates to quantum computing, a completely different field, superficially.

How does it relate to quantum computing then?
BC: Quantum computers are made up of qubits, which can exist in not just a state of zero or one, but a mix of the two. These days, one of the big challenges in quantum computing is to store information in a physically robust way because qubits are very delicate things. The answer is to build a network of interconnected qubits in such a way that that network is robust against damage to the fragile quantum states of some of the interconnected qubits.
JF: This network of qubits is a quantum error-correcting code. Now, we are learning that it looks like space is built in much the same way –like a giant quantum computer. If you take some chunk of space-time, the entanglement between that region and the rest of the universe is enough to encode the interior of the region. And that seems to be true for every bit of space everywhere. You can destroy qubits on the boundary and you still don't destroy the information in the interior. It's a really clever way of encoding information that's robust, and one that nature seems to have alighted on.

What does this mean for reality as we know it?
JF: We picture ourselves as being local. Our experience of the world is that we deal with local objects interacting locally with each other. But it appears that there is an equivalent description, which is highly non-local. That already shatters your perception of what you think you are, right?

Space is not fundamental, it is emergent. All that really exists is information. Space and time emerge from a bunch of entangled quantum units that have logical relationships with each other. These units, we're not quite sure what they are, they could be like qubits or something, but they interact with each other quantum mechanically. And the result of that is the universe we live in.
BC: We really do seem to be saying that space and time emerge from something deeper, which is absolutely fundamental. ▮

Abigail Beall is a features editor at *New Scientist*

RICA I.

Meat-free mutts and moggies

Pet food has a massive impact on the environment, so is it safe to feed your cat or dog a vegan diet, asks **Graham Lawton**

WHEN I finally gave up eating meat, I found that I couldn't actually stop buying meat. My two teenage sons were both big fans of the stuff and my two cats ate nothing but meat. And while I thought the boys might be weaned off it, the cats not so much. I knew that vegan dog diets were available, but assumed that they were suboptimal, and it never even crossed my mind that cats could do the same without losing a few of their nine lives.

Now though, the boys have left home and the cats have sadly passed away. I'm meat-free at last. And when we get our next cat, and possibly dog, I'm considering making them meat-free too. Because far from being biologically impossible, the evidence is growing that cats and dogs can be perfectly content on a veggie or even vegan diet. Indeed, they may be healthier than those fed conventional pet food.

Nevertheless, vets still tell owners not to impose plant-based diets on dogs and cats, warning that they are probably unhealthy, possibly cruel and potentially illegal. So what is the truth about plant-eating pooches and moggies?

Cats, dogs and their dinners are big business. In 2018, there were about 370 million pet cats and 470 million pet dogs in the world, together wolfing down $134 billion of chow each year. And the pet food market is growing. In the UK, it rose 17 per cent in the five years to 2019.

Thousands of new pet food products come onto the market every year. In recent years, a lot of those have been plant-based, as the human trend for vegetarianism, veganism and flexitarianism grows and people also think more about the diet of their pets. "Many people these days are much more concerned than they used to be about the environmental impacts of food production, in particular the livestock sector," says Andrew Knight at the University of Winchester's Centre for Animal Welfare in the UK. "They're looking at changing their own lifestyles, and they're starting to look at their cats and dogs as well." Concerns over the healthiness of standard pet foods is also driving the trend, he says.

This concern is also pushing some owners towards premium pet foods and paleo-style diets consisting of raw meat, blood, offal and bone marrow, which are also called biologically-appropriate raw food diets, or BARF for short.

But plant-based diets are where the real growth is. The market for these is expanding faster than the market as a whole – it was worth $9 billion globally in 2020 and is projected to almost double by 2028, says Knight. Current estimates suggest that under 1 per cent of the world's pet cats are fed a vegan diet, alongside 1.6 per cent of dogs.

However, just because so many owners are buying into these diets doesn't mean that their pets are thriving on them – or that the environment is benefiting (see "Environmental paw prints", page 46).

Any look at the merits of plant-based pet diets must first delve into the basic nutritional biology of cats and dogs. Left to their own devices, both like to eat meat, which is a big reason why people find it hard to believe they can survive without it.

Dogs are clearly the more veggie-friendly of the two. Though descended from wolves, which eat almost exclusively meat, tens of thousands of years of coevolution with humans have bent the diets of dogs towards omnivory. They will eat meat given half a chance, but there is nothing a dog needs nutritionally that can't ultimately be obtained from plants, says Knight.

Cats, meanwhile, are still only semi-domesticated and remain obligate carnivores, which means they need certain nutrients only present in meat. One of these is the amino acid taurine, which is virtually non-existent in plants and which cats can't synthesise. They also need a dietary source of arachidonic acid, which is found mainly in animal fat. Their metabolisms are poor at converting carotenoids from plants into vitamin A, so need to get it from animal sources, and they also prefer an animal-derived form of vitamin D called cholecalciferol over the plant-based form ergocalciferol. Last but not least, they derive most of their energy from amino

›

New Scientist Live
Discover more climate-friendly tips by visiting our Earth Stage newscientistlive.com

ENVIRONMENTAL PAW PRINTS

One of the main motivators for putting cats and dogs on a vegan diet is the environmental impact of pet foods containing meat. "The livestock sector is a significant contributor to land and water use, climate change and biodiversity loss," says Andrew Knight at the University of Winchester, UK. "The environmental impacts of pet food are potentially enormous."

There is a widespread belief that pet foods contain mostly abattoir waste and are therefore environmentally sound. But this isn't true, says Knight. In the US, about a third of meat going into pet food is diverted from the human food supply. In the UK and the rest of Europe, all the meat going into pet food has to be fit for human consumption. However, as the British Veterinary Association points out, "fit for" doesn't mean "wanted for". A lot of what goes into pet food is technically edible but rarely eaten – tripe, offal, pigs' trotters, udders and chicken feet.

In 2017, Gregory Okin at the University of California, Los Angeles, estimated that 25 to 30 per cent of the environmental impacts of animal agriculture in the US are directly attributable to pet food, which would make pet food responsible for about 5 per cent of global greenhouse gases. That is probably an overestimate, as Okin didn't consider how much food comes from abattoir by-products, says Knight, but even if its footprint amounts to 2 per cent of emissions, that would be significant.

Knight has made some initial calculations on the environmental impacts of switching all the world's domestic cats and dogs to veganism. He reckons that the resources used to create meat-based pet food could be diverted to feed 10 million people a year. Plus, it would mean more than a billion land animals each year wouldn't need to be slaughtered and there would be vast savings in terms of land, water, fossil fuels and greenhouse gas emissions as well.

acids and fats instead of dietary glucose, which means they have much higher protein and fat requirements than dogs. Feral cats obtain about half of their calories from protein and half from fat, mostly by eating small mammals and insects, and about 2 per cent from carbohydrate-rich sources such as grass.

This doesn't look like a promising starting point for quitting animal products, but, in fact, all of these needs can be fulfilled from plants and supplements, says Knight. Taurine is a bit of a red herring: standard cat meats already need to be fortified with synthetic taurine because the heat treatment used to pasteurise these pet foods destroys a lot of the naturally occurring protein, he says.

"No species has any particular need for meat, or any other particular ingredient," says Knight. "What they have requirements for is a set of nutrients in a formulation that's sufficiently digestible and palatable." That applies equally to other carnivorous pets, including ferrets, snakes, lizards and fish.

From that perspective, it also matters little what the main source of protein is. For this, some plant-based pet foods rely on vegetables, others on yeast or other fungi or seaweed. Eggs, milk and fish are also used in vegetarian and pescatarian foods. But it hardly matters as long as the diet is "nutritionally sound", meaning it conforms to the legal requirements to meet all the animals' nutritional needs.

Feral cats obtain most of their calories by eating small mammals, birds and insects

SHUTTERSTOCK/LOSONSKY

Happy hounds

The proof of any pudding is, of course, in the eating. Just because nutritional needs can be met doesn't mean the diet is acceptable. "Some people have claimed that it's cruel to maintain cats and dogs on vegan diets," says Knight.

To find out whether happiness was being compromised, Knight and his colleagues surveyed nearly 4000 dog and cat owners about the extent to which their animals were enjoying their food, guided by established behavioural indicators.

For dogs, signs that food is highly palatable include wolfing it down, begging for more, hanging around the empty bowl, stealing it from cupboards and bins, and becoming aggressive over food. Dogs don't necessarily turn their noses up at less palatable food, but eat it with less obvious gusto. If cats like what they just ate, they lick their chops, groom their faces and half-close their eyes; if not, they flick their tails and ears, lick their noses and groom their bodies.

Knight's survey included 2300 dogs and 1100 cats on a variety of diets and found no significant differences in terms of palatability between them. "The animals eating the vegan diets seemed to enjoy their meals just as much as those on the meat-based diets," he says.

Of course, food that tastes good isn't necessarily healthy. The first large-scale study of the health effects of veganism on pets was published last year. A team led by Adronie Verbrugghe at the University of Guelph in Ontario, Canada, surveyed over 1000 cat owners, 18 per cent of whom fed their cats a strict plant-based diet. The researchers upped the proportion of vegan animals by inviting customers of Ontario's largest plant-based pet food retailer to take part. The survey asked owners to detail their cats' health problems, examine their stools, give them a "body condition score" and report their overall perception of the health of the cats.

Given cats' meaty nutritional needs, the researchers expected to find plant-eating cats to be in poorer health than the meat-eaters.

There is nothing a dog needs nutritionally that can't ultimately be obtained from plants

GOLERO/GETTY IMAGES

If anything, they found the opposite, with lower incidences of gastrointestinal disorders, better body condition on average and a higher proportion reported to be in very good health.

"We were surprised by these findings," says team member Sarah Dodd. "We certainly expected there to be a couple of increased health conditions with the plant-based diet, so it was interesting to see that wasn't the case."

Dodd accepts that the study has limitations. Respondents were self-selected, possibly opening up the results to bias. Nonetheless, says Knight, who has a similar study of 1400 cats ongoing, "that was hugely exciting because it's contrary to the widespread expectation that many people have, which is that cats couldn't do well on vegan diets".

Dogs also do well. A recent study by Knight surveyed more than 2500 dog owners, about half of whom fed their dogs conventional dog food, a third raw meat and the rest a vegan diet. He asked them to track, over the course of a year, seven indicators of health, including visits to the vet, diagnoses, medications and their personal perception of their dog's health. The healthiest dogs were those on raw meat, while the sickest were eating conventional food. However, the raw meat dogs were significantly younger than the others, and when Knight factored this in, the vegan diet turned out to be the best.

> "Dogs maintained on nutritionally-sound vegan diets have health outcomes at least as good or better than those maintained on conventional or raw meat-based diets"

One limitation of the study is that it only considered the dogs' main meals, not treats, table scraps or food scrounged from elsewhere. Nonetheless, says Knight, "I think our study represents what occurs in the real world. When you look at the weight of evidence, it's very clear that dogs maintained on nutritionally-sound vegan diets have health outcomes at least as good or better than those maintained on conventional or raw meat-based diets."

Two words are key here: "nutritionally sound" (see "How to turn your cat or dog meat-free", left). For dogs and cats, that means a diet meeting rules issued by authorities such as the European Pet Food Industry Federation and the US Association of American Feed Control Officials, both based on nutritional requirements established by the US National Research Council in 2006.

That is a potential problem for all pet diets, not just vegan ones. A number of studies have found that conventional meaty pet foods sometimes fall short of these standards, can contain DNA from animals not listed on the packaging and often include animal proteins that some cats and dogs are allergic to.

BARF diets, meanwhile, have been found to be deficient in certain micronutrients and often come with an unwelcome garnish of bacterial pathogens and intestinal parasites.

Vegan diets have similar problems. When Dodd analysed 26 plant-based pet foods available in her local area in 2018, she found that only four – all for dogs –

›

HOW TO TURN YOUR CAT OR DOG MEAT-FREE

If you decide it is time to wean your cat or dog off meat, it can be tempting to design a DIY diet. But advocates and critics alike agree that this is barking up the wrong tree.

"Although we wouldn't recommend it, it is theoretically possible to feed a dog a vegetarian diet," says Justine Shotton, president of the British Veterinary Association and a critic of vegan pet diets – especially for cats, which she says must eat meat. "But owners would need to take expert veterinary advice to avoid dietary deficiencies and associated disease."

"It's technically possible to make a homemade diet by following recipes and adding supplements," says Andrew Knight at the University of Winchester, UK, who disagrees that cats cannot go vegan (see main story). But there have been quite a lot of studies showing homemade diets are often nutritionally incomplete. His own surveys also found that vegan pet foods were more likely to live up to the nutrient profiles on the packaging, perhaps because the companies are trying harder to create nutritionally-sound diets. "I would suggest people just purchase a diet which has been formulated by a reputable company produced to good standards," he says.

SHUTTERSTOCK/ALEKSEY BOYKO

Signs your dog likes a food include wolfing it down, stealing it from cupboards and begging

met US standards and only one the stricter European ones.

A more recent analysis by Knight found that the problem wasn't the diets per se, but the way they were produced. He analysed 19 meat-based and 10 alternative diets, including vegan, vegetarian and insect-based, and found that if they actually delivered what was listed on the tin, they would be nutritionally sound. However, they fall short for a number of reasons, including seasonal variability in the nutritional quality of the ingredients and glitches such as overcooking and the addition of additives that can degrade nutrients.

Caution needed

Still, some vegan diets aren't cutting the mustard, as illustrated by a recent case study from Toulouse, France. Two young cats from the same household were taken to a vet after they became lethargic and bloated and lost their appetite. Tests found that the animals were anaemic, had lost muscle mass and were profoundly deficient in vitamin B9, or folate. The vet ascertained that, five months earlier, the cats had been put onto a plant-based diet and suggested switching back to their old food. The owners – both vegan – refused, and so the vet prescribed nutritional supplements.

Three months later, the cats were still ill and the owners caved in. Once on meat, both cats recovered completely. The vet had the original plant-based food analysed and discovered that it didn't meet the minimum requirement for folate and several other B vitamins.

Such cases notwithstanding, dogs and cats fed a nutritionally sound vegan diet can thrive. This is probably down to two main factors, says Knight. One is a lack of food allergens in vegan diets. Another is that, as with humans, vegan cats and dogs tend to be leaner, possibly because conventional pet food is packed with calories. "This is important, because being overweight and obese is one of the most common and important health concerns in cats and dogs today," he says.

Vets, however, remain deeply sceptical. "There is currently a lack of robust data mapping the health consequences of feeding a vegan diet to a large number of dogs over many years," says Justine Shotton, president of the British Veterinary Association (BVA). "We look forward to seeing further research on whether non-animal protein sources can meet a dog's dietary requirements over the long term. Cats are obligate carnivores and should not be fed a vegetarian or vegan diet."

Vets and professional organisations have also, on occasion, issued vague legal threats to people who put their pets on vegan diets. The authors of the French cats case study, based at the National Veterinary School of Toulouse, point out that the law in France specifies that animals "must be placed by their owners in conditions compatible with the biological imperatives of the species", which they say calls into question the legality of giving cats a plant-based diet. The BVA has similarly pointed out that under the UK's animal welfare legislation, owners have a duty of care to provide an adequate diet and could face prosecution if they don't.

Despite the hurdles, Knight and his team are confident that there is enough evidence that cats and dogs on a nutritionally-sound, meat-free diet will prosper. "There's a revolution under way in this sector, driven by consumers and the concerns that they have over climate change and the health and well-being of their cats and dogs," says Knight. "This isn't a fad." ∎

LAB-GROWN MOUSE MEAT

For cat and dog owners who don't want to buy traditional food, but also don't want to deprive their pets of meat, there is an alternative on the horizon: cultured, or lab-grown, meat. This edible tissue, grown from stem cells, has been in development for human consumption for more than a decade and recently made a breakthrough onto a restaurant menu at 1880 in Singapore.

The only company currently in the cultured pet food space is Because, Animals, based in Vienna, Austria. It already sells plant-based treats, but is working on cultured mouse meat for cats. It has tested a prototype on about 20 cats and hopes to launch the product in 2023. It is also working on cultured rabbit meat for dogs, but sees cats as the priority. Many people aren't willing to feed their cats a non-meat-based diet, says CEO Shannon Falconer. "So what are they supposed to do? This product provides the first humane and sustainable meat-based product that they could feed their cat."

Graham Lawton is a features writer at *New Scientist*

Master's degrees in Neuroscience

Embrace the world of neuroscience and human behaviour, and be ready to respond to challenges and new discoveries. Our fully online courses will help you future fit your life in this exciting field of research and therapy. Commonwealth Supported Places (CSPs) are available for eligible Australian domestic students (quotas may apply).

Master of Neuroscience

- Completely online
- Neurobiology as well Clinical Neuroscience studies
- Taught by neuroscientists who are registered psychologists
- Choose from 3 pathways: General, Clinical, Research

Master of Neuroscience and Education

- Completely online
- Taught by both neuroscientists and education experts
- Learn how the brain works and how students learn
- Includes a research project of your choosing

Apply now to start on 27 February

une.edu.au/ns-neuroscience

1800 818 865 (Australia) • +61 2 6773 2135 (International)

une
University of New England
Armidale Australia

Future fit your life

University of New England CRICOS Provider Number 00003G

New Scientist
Newsletter

Health Check

Get the most essential health, diet and fitness news in your inbox every week

Hundreds of new studies about our physical and mental well-being are published every week, but the results can be conflicting and confusing. Our weekly newsletter gives you the health and fitness news you can really trust – more important now than ever.

Get a digest of the week's most essential health stories, including the latest covid-19 news, in your inbox every Saturday, carefully curated by *New Scientist* health reporter Clare Wilson.

Keep up to date with the latest biomedical science and sign up for free at:
newscientist.com/healthcheck

Clare Wilson

Scan me to sign up

Our family of newsletters

newscientist.com/newsletter

The Weekly
The Daily
Fix The Planet
Health Check
Launchpad
Lost in Space-time
Our Human Story
Wild Wild Life

The back pages

Puzzles
Try our crossword, quick quiz and logic puzzle p53

***Almost* the last word**
Could you decode a word written on a ball of string? p54

Tom Gauld for *New Scientist*
A cartoonist's take on the world p55

Feedback
This year's Ig Nobel prizewinning ideas and discoveries p56

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p56

Science with children

Magnetic attraction

This is the simplest electric motor you can make, says **Alom Shaha**, but it is utterly delightful and children will love it

Alom Shaha is a physics teacher at a comprehensive school, and author of books including *Mr Shaha's Marvellous Machines*. Follow him @alomshaha

What you need

An AA, AAA or C battery
One or more neodymium magnets, ideally disc-shaped
A flat-headed metal screw, at least 2 cm long (make sure that it sticks to the magnet)
A piece of copper wire, around 15 cm long (insulated will do)

Next week

The science of cooking

THROUGHOUT history, humans have found ways to make their lives easier. Arguably, the machine that has most eased the burden of work for humans is the electric motor – a device that transforms electricity into motion.

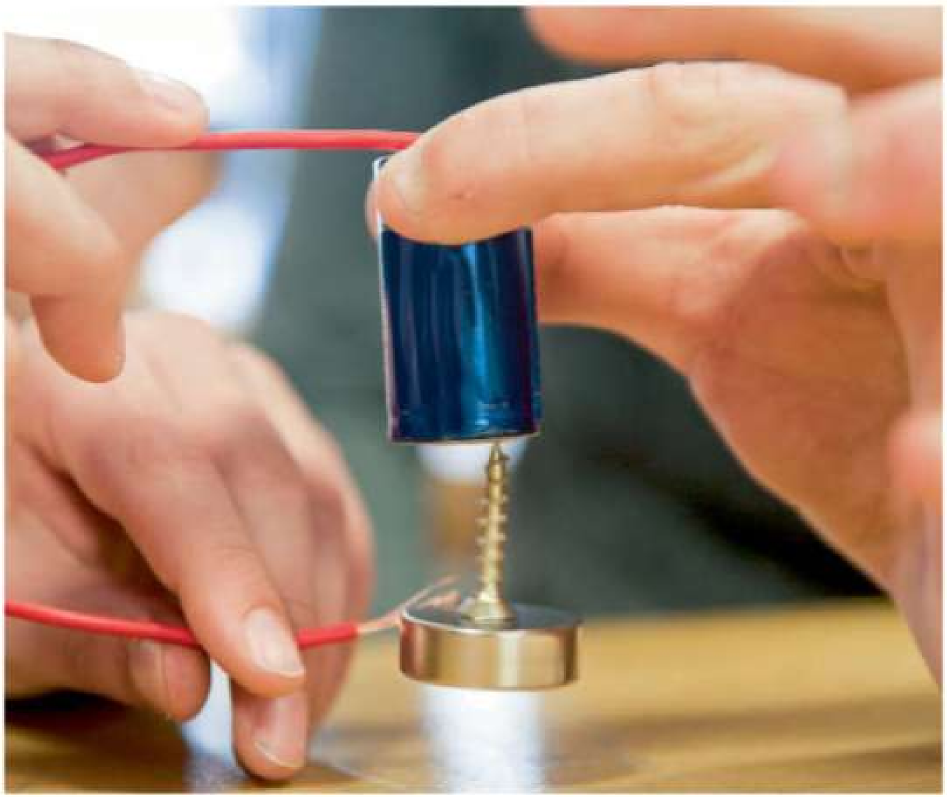
You can find these at the heart of every washing machine, dishwasher, lawn mower, vacuum cleaner, food processor and in countless other household appliances and industrial machines. I imagine quite a few readers of this magazine will have, like me, delighted in extracting the motor from a broken toy or gadget and making it spin by connecting a battery to its terminals.

However, I suspect fewer of you will know just how easy it is to show a child how to construct their own electric motor from bits and pieces that you probably have lying around the house.

Begin with a piece of copper wire. If your wire is insulated, strip at least 1 centimetre of insulation from each end. Then attach the flat head of a screw to one of the flat sides of a neodymium magnet.

Hold a battery up with one hand and touch the tip of the screw to the bottom of it. You should find that, when you let go, the screw will remain attached and hang down from the battery. If you can't get this to work, you probably need a stronger magnet, or a lighter one.

Using a finger from the same hand with which you are holding the battery, hold one end of the wire so that it lies flat against the top of the battery.



VITRANC/GETTY IMAGES

Lightly touch the other end of the wire to the side of the magnet, and you should find the screw and magnet start spinning. Please take care when doing this – the wire will get hot if you leave it there for too long, so don't keep it in contact with the magnet for more than a few seconds at a time.

As well as being utterly delightful, this simple electric motor illustrates a key aspect of the natural world that comes as a surprise to many children: electricity and magnetism are actually just two sides of the same phenomenon, electromagnetism.

Touching one end of the wire to the top of the battery and the other end to the magnet completes an electric circuit, allowing a current to flow through the wire, the magnet, the screw and the battery. An electric current such as this will always generate a magnetic field around itself.

A simple explanation of why the magnet spins is that, just as two permanent magnets in the same vicinity will exert a pull or push on each other, the magnetic field of the neodymium magnet interacts with the magnetic field of the current that flows through it, and does so in such a way that the magnet is made to spin.

Once you have got this to function, try asking the child you are working with how they could make the motor spin faster, or how they could make it spin in the opposite direction. ▮

These articles are posted each week at **newscientist.com/maker**

Ri The Royal Institution
Science Lives Here

Discover our new autumn season of events

Sign up to our newsletter to see what's on at the Ri, discover great science content and get exclusive discounts straight to your inbox

- Science talks
- Free museum
- Faraday's lab
- Family events
- Digital content
- Workshops and courses

rigb.org/sign-up

@Ri_Science @RoyalInstitution

GALAXY
ON GLASS

SPECTACULAR WALL ART FROM ASTROPHOTOGRAPHER CHRIS BAKER

www.galaxyonglass.com
chris@galaxyonglass.com +44 (0) 7814 181647

NEW SCIENTIST LIVE
Come and visit me and see my art on the Galaxy on Glass stand F12 at New Scientist Live, 7th-9th October

TREAT YOUR SHELVES

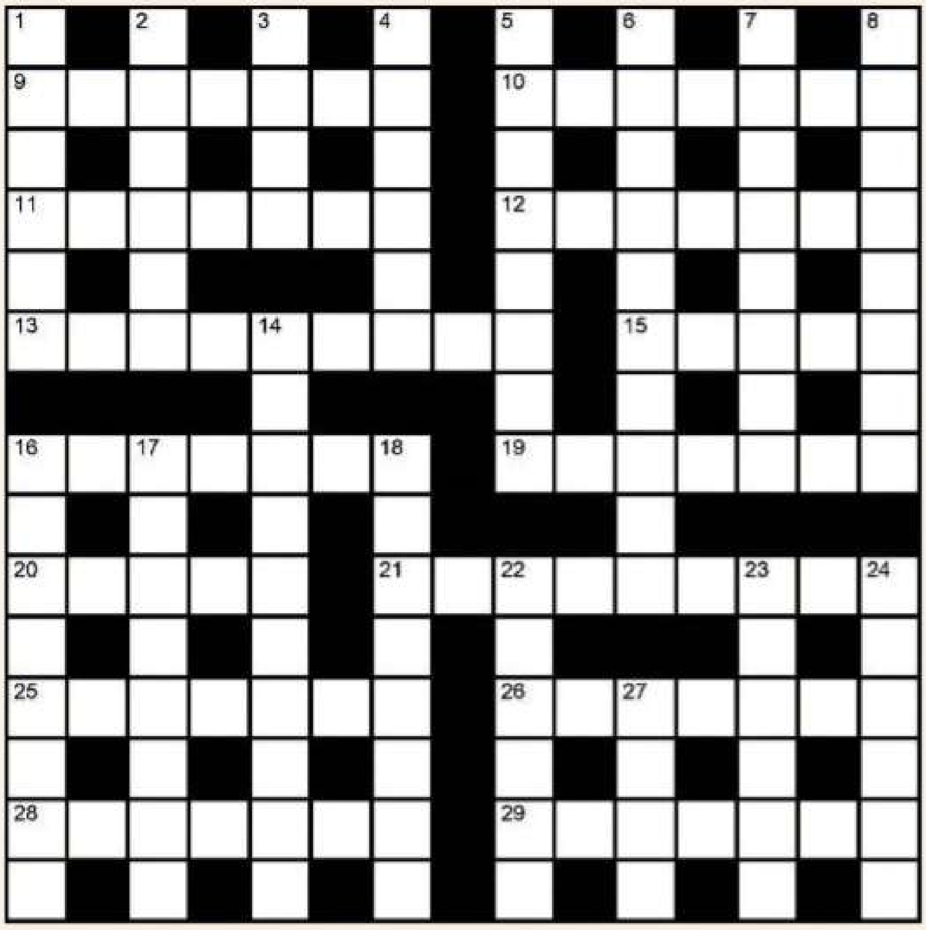
Explore our range of fantastic books from award-winning *New Scientist* journalists and renowned science writers.

New Scientist Shop

shop.newscientist.com

worldwide shipping available

Quick crossword #117 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

9 Parasite (7)
10 Unspecified large number (7)
11 Ir (7)
12 $\sin^{-1}$ (7)
13 Collagen derived from fish swim bladders (9)
15 Type of titanium alloy (4,1)
16 Solar ray (7)
19 Archaic name for tungsten (7)
20 Robert ___, botanist known for observing the motions of pollen (5)
21 Cloud computing platform (4,5)
25 Cockerel (7)
26 Replace 1.999 with 2, perhaps (5,2)
28 Of copper (7)
29 Logical proposition (7)

DOWN

1 Crewed US spaceflight programme from 1961 to 1966 (6)
2 Classically, numbers less than 10 (6)
3 Doughnut shapes (4)
4 Mild form of aphasia (6)
5 Large South American bird that might be crestless or razor-billed (8)
6 1987 sci-fi parody film (10)
7 Electrical circuit component (8)
8 Communication system within building (8)
14 2011 book on Indian science by Angela Saini (4,6)
16 Take away (8)
17 Type of genetic mutation (8)
18 Point at which Earth's satellite becomes visible from Earth (8)
22 Moon of Jupiter (6)
23 "Buzz" ___, second man to walk on the moon (6)
24 Johannes ___, 17th-century German astronomer (6)
27 Middle layer of the eye (4)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #170

1 In astronomy, what does FBOT stand for?

2 Where in the body would you find an ulna?

3 An organism that lives within a plant without causing disease is known as a what?

4 Which desktop computer is the highest-selling single model of all time, according to the *Guinness Book of World Records*?

5 What is the world's largest tropical wetland?

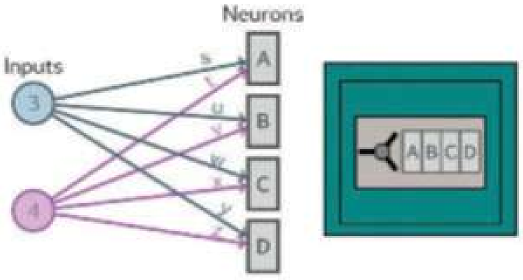
Answers on page 55

Puzzle

set by Peter Rowlett

#186 Neural network

Professor Beryl Brainstein is developing a robot called NewRon that uses a so-called neural network to crack open a safe that has a four-digit code. Brainstein gives NewRon two fixed input numbers (she picks 3 and 4) and NewRon uses an algorithm to generate four output numbers (A, B, C and D), which are NewRon's guess for the safe code.



Each output is connected to the two inputs by arrows labelled with a number called a weight (s, t, u...). NewRon multiplies each input by the weight and adds the resulting numbers to get the output. For example, the inputs 3 and 4 are connected to A by weights s and t, so NewRon's guess for A will be 3s + 4t. If s = 2 and t = 0.5, then A would be 8. NewRon's task is to adjust the weights until the output ABCD opens the safe.

Brainstein sets the code for the safe as 1221 and starts NewRon, which whirs for a moment, trying different weights, and... clank, the safe opens. Four of the correct weights are zero and the other four are all different. What are the non-zero weights?

Solution next week

Unravelling words

If you wrote a word on a ball of string, then unravelled it, how challenging would it be to decipher the word?

Bryn Glover
Kirkby Malzeard, North Yorkshire, UK
I would expect that a word written on the ball pictured (below) could never be deciphered.

In any coding or ciphering process, the vital factor is that the coder and intended decoder operate according to a logical, predictable process known to both. The first step for a decoder is to discover what this process is.

Some balls of string are wound systematically by machinery, producing a regular cylinder, for example. In such a case, it may be possible to predict the position of any small segment of the string, even taking into account the fact that the circumference of the "ball" will increase as the wrapping proceeds.

But the ball illustrated has clearly been created by a random process, which, by definition, means it would be impossible to work backwards to recreate any words that had been written on it.

ANTON STARIKOV/ALAMY

ANDRIY POPOV/ALAMY

Cracking our knuckles makes a popping sound, but does this do us any good – or harm?

This week's new questions

Cracking stuff **Why do our knuckles and joints make a popping sound when cracked? Does it do us any good or harm?** ***Noah Horne****, Patrick Space Force Base, Florida, US*

Looking back **If the universe originated at the big bang 13 billion years ago, how can there be stars that are 30 billion light years away?** *Sarah Bloxham, via email*

In a spin

Is jet lag worse if you travel east rather than west? Does going with or against the rotation of Earth have an impact?

@JohnRei78302499
via Twitter
Whenever your day gets shorter, your body has a hard time adjusting. I am a long-haul airline pilot. Flying east is always the problem. One of the hardest things to adapt to is the jet lag. It plagues the lives of those in my profession.

Dorothy Graham
Macclesfield, Cheshire, UK
As a dual national of the UK and the US, I have travelled back and forth between these places many times. The jet lag going westwards to the US isn't too bad, but flying eastwards home to the UK is definitely always worse.

My theory is that the trip from the UK to the US, going west and hence travelling to earlier time zones, is like staying up late and sleeping in the next day. But coming back, you lose a night's sleep and it takes at least three days to recover, no matter what you do. When there are no clocks or cues from light, I believe that the human body tends to adopt a 25-hour day. Maybe this is why it is easier to cope with extra-long days rather than extra-short nights.

However, some friends who worked abroad were convinced that jet lag was always worse coming home, whatever the direction of travel.

Richard Swifte
Darmstadt, Germany
It is widely acknowledged that jet lag is worse when travelling east, but this has nothing to do with the direction of Earth's rotation.

Like many creatures, humans have a circadian rhythm that follows a 24-hour period and is kept in sync by the eyes' response to natural light levels over the day. In fact, various studies indicate the average period is slightly longer than 24 hours, which would make it slightly easier to cope when flying west towards earlier time zones.

But probably the main reason is simply that it is easier to get to sleep later rather than earlier than one's normal bedtime.

Hillary Shaw
Newport, Shropshire, UK
The human body clock is nearer 25 hours than 24 hours, as shown by experiments where people live for long periods in caves, with no clues as to day or night. Therefore, travelling westwards should be easier than going east and having to get up earlier than your brain "wants" to.

For short journeys east, say two time zones into Europe from the UK, this isn't an issue: most of us adapt to the 1-hour biannual clock change within a day or so.

For longer journeys east, I force myself to stay awake the whole time – for example, for around 24 hours to Beijing, seven time zones ahead of the UK. Then, after arrival, I sleep for much longer than the usual 8 hours. Next morning, I am acclimatised.

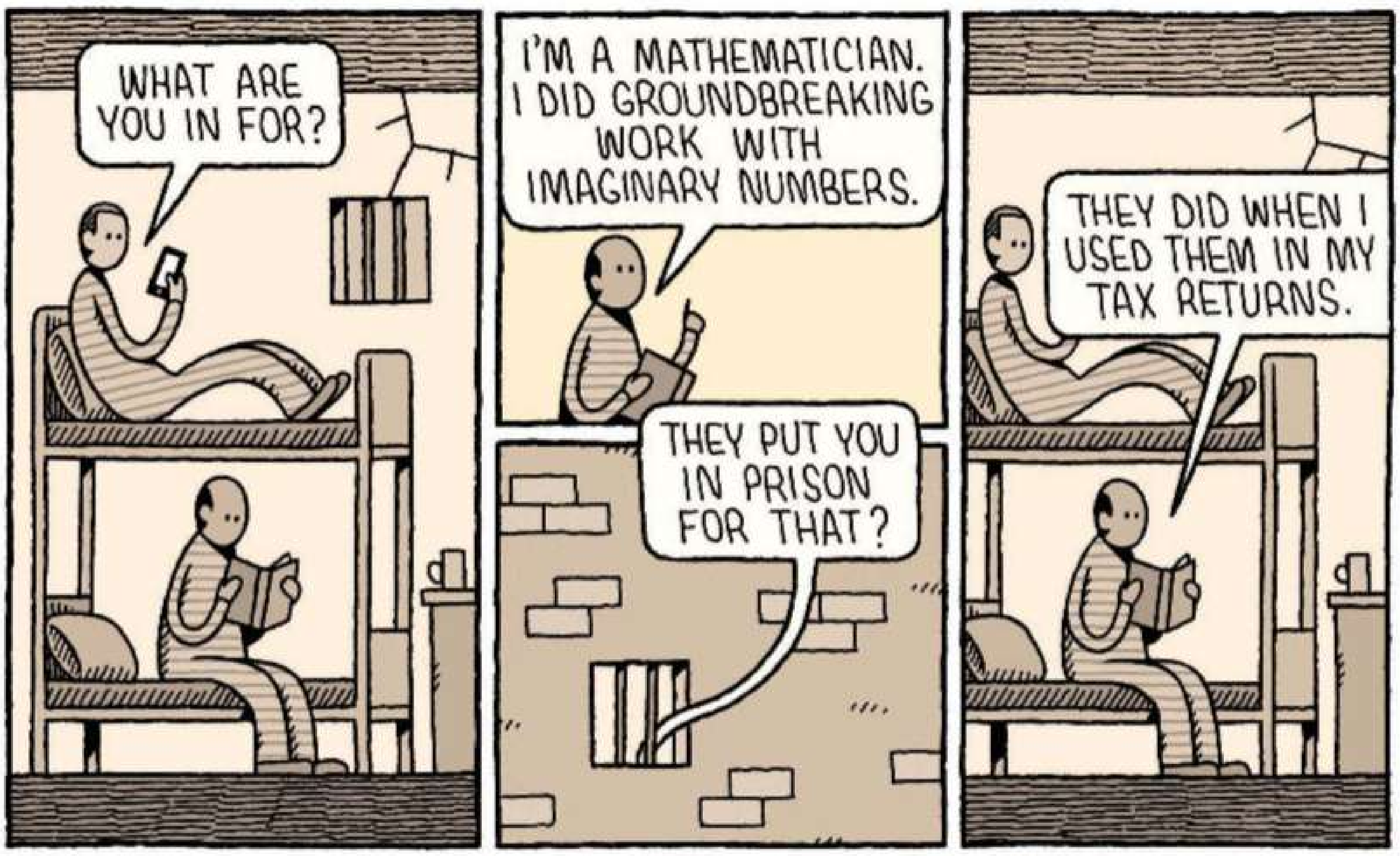
Simon Dales
Oxford, UK
Yes, the direction you fly does make a difference, as shown by analyses of US National Football League match scores, which show a clear disadvantage for the teams travelling westwards.

Teams going west, say from New York to San Francisco, play later in their physiological day than the locals. For a 6pm kick-off, they feel as if it is 9pm, and well past their bedtime when the match finishes. But Californians competing in a match in New York play in their afternoon.

Nik Kelly
via Facebook
It also depends if you are a dawn or a dusk person: the former finds it

Want to send us a question or answer?
Email us at lastword@newscientist.com
Questions should be about everyday science phenomena
Full terms and conditions at newscientist.com/lw-terms

Tom Gauld
for New Scientist


WHAT ARE YOU IN FOR?
I'M A MATHEMATICIAN. I DID GROUNDBREAKING WORK WITH IMAGINARY NUMBERS.
THEY PUT YOU IN PRISON FOR THAT?
THEY DID WHEN I USED THEM IN MY TAX RETURNS.

better going east, the latter going west. The same applies when the clocks go forwards or back by an hour. As a night owl, I prefer the "fall back" when the clocks go backwards in autumn.

Weedy diet

What stops us from processing weeds into tasty and edible food? (continued)

Penny Waters
Rettendon Common, Essex, UK
I wondered what replies would come from the back-to-front question about processing weeds into tasty and edible food (27 August), as this is my field (yes, a pun!) and has been since I began observing and comparing plant leaves on the lawn at 4 years of age.

Before shops, everyone ate "weeds" or native plants. Wild plants can be both food and medicine. The most comprehensive book on this topic is *Eating on the Wild Side* by Nina Etkin. It is the best book to open the mind regarding ethnobotany and how we obtained knowledge about plants.

> "Jet lag is worse when travelling east, but some people think it is worse when coming home, whatever the direction"

It appears that wherever people moved around the world, they partook of the plants around them. Hunters weren't always successful, but plants can't get away, so many plants have been used by people ever since, although much plant knowledge gets lost with the movement out of the countryside.

One of your previous correspondents, Charles Merfield, discussed how sow thistle is considered a weed by some farmers in New Zealand. This grows in my garden in Essex and the young leaves are very yummy. English hogweed is tasty too and sometimes tastes of coconut.

The most delicious cherry in the UK is the wild one. Wild peas are native here too, and they are more delicious than any hybrid.

Nettles are a wonderful example of the deficiency of vegetables bought from the shops. For example, the highest calcium content in bought veg is in curly kale at 150 micrograms per 100 grams (cooked), according to the US Department of Agriculture, compared with 481mg/100g in cooked stinging nettles. Nettles also have high amounts of other minerals, so are an excellent food for bones.

I published my phytotherapy dissertation some years ago on the potential for wild food and herbal medicine from a plot in Essex, based on knowledge of the plants on this land on a north-facing slope that had never been touched by farm machinery. I had been eating from the self-sown wild plants there and this opened my mind to the wonder of plants and our ignorance of them.

Wild plants grow when and where they want and hold secrets that only they can tell you – about them and the place where they are growing. ▮

Answers

Quick quiz #170
Answers

1 Fast blue optical transient, a type of explosion similar to a supernova
2 In the forearm – it is a long, thin bone running parallel to the radius
3 An endophyte
4 The Commodore 64
5 The Pantanal, found predominantly in Brazil

Cryptic crossword #92 *Answers*

ACROSS 1 Abseil, **5** Skinks, **8** Tech, **9** Collect, **10** Mercator, **11** Sump, **13** Pollination, **16** Oral, **18** Vermouth, **20** Yttrium, **21** Ewes, **22** Ampere, **23** Tassel

DOWN 2 Beekeeper, **3** Ethical, **4** Licit, **5** Solaria, **6** Items, **7** Kit, **12** Monotreme, **14** Invoice, **15** Isomers, **17** Latte, **19** Remit, **20** Yam

#185 Cheque out
Solution

The original cheque was for £28.64, while the cashier gave Matthew £64.28, so he still has £57.28 to spend. Call the original cheque £a.b. The cashier hands over £b.a, and we know that in pence, $100b+a - 700 = 200a + 2b$. Rearranging, you get $98b - 700 = 199a$, and we are looking for positive whole number solutions. You can speed things up by spotting that 98 and 700 are both divisible by 14, so $14(7b - 50) = 199a$, which means that 199a is also a multiple of 14, and hence a itself must be a multiple of 14. Quick trial and error reveals that only a=28 gives a whole number for b (=64).

The best (and also the non-best) science can make people laugh, then think, and every year the Ig Nobel prizes serve up some glittering specimens of this. The 32nd First Annual Ig Nobel prize ceremony – entirely online again, thanks to the pandemic – has given us this year's new winners and, as per tradition, Feedback regifts them to you.

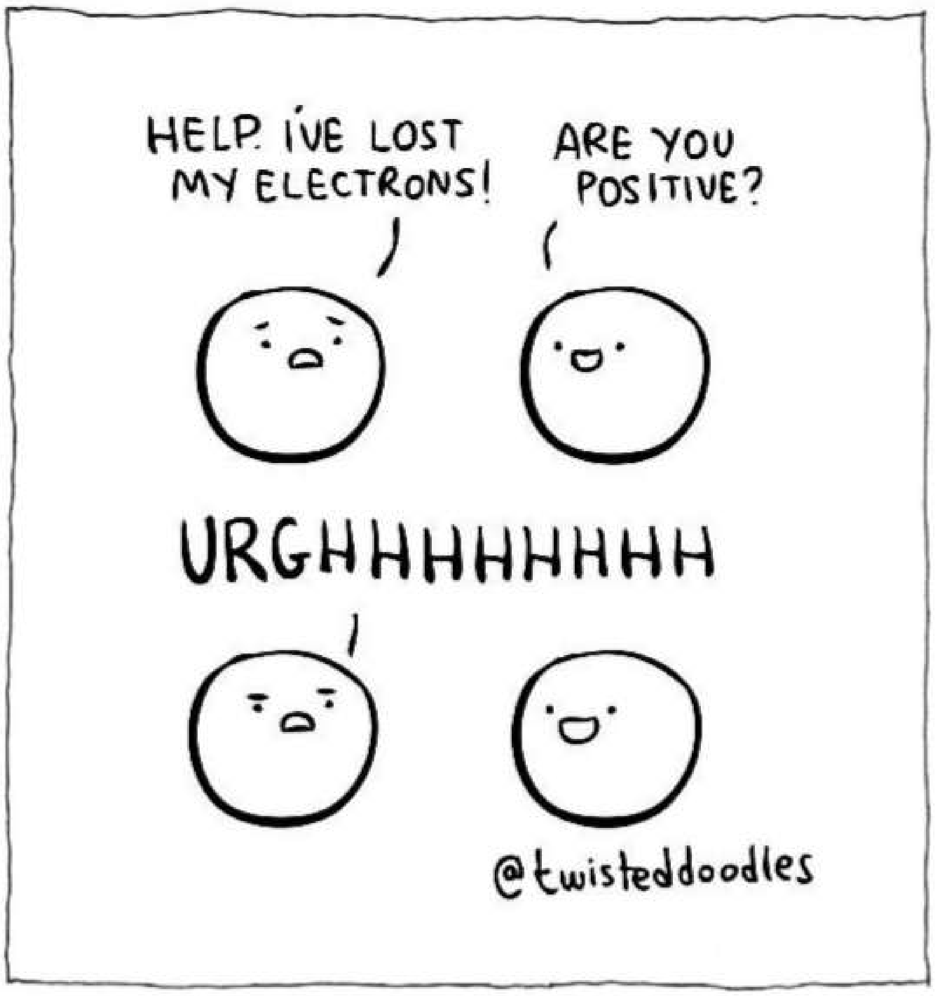
Surfing ducklings

There is subtle mystery in the way ducklings manage to swim in formation. Frank Fish, who is a biologist and a human being, did experiments on this in the early 1990s. He deployed an artificial "mother duck" in a flow tank, analysing the physics on display when real ducklings swam in the wake of that decoy. Fish concluded that vortices – the swirling of the water – explain much about the efficiency of swimming in formation.

A quarter of a century later, hydrodynamicist Zhiming Yuan and his colleagues developed computer models of mother and baby ducks swimming together. Yuan's group concluded that "wave-riding" – surfing, essentially – reveals quite a lot about the physics. Fish and Yuan's team were jointly awarded this year's Ig Nobel Physics prize. Together, they are a plum example of scientists finding different ways to analyse a phenomenon that is way more complex than it looks.

Those were baby mallards that Fish examined, the same species that ornithologist Kees Moeliker came across on 5 June 1995. The resulting publication, called "The first case of homosexual necrophilia in the mallard *Anas platyrhynchos* (Aves: Anatidae)", earned Moeliker the 2003 Ig Nobel Biology prize.

Twisteddoodles *for New Scientist*


HELP I'VE LOST MY ELECTRONS!
ARE YOU POSITIVE?
URGHHHHHHHH
@twisteddoodles

Got a story for Feedback?
Send it to feedback@newscientist.com or New Scientist, Northcliffe House, 2 Derry Street, London W8 5TT
Consideration of items sent in the post will be delayed

I should be so lucky

Alessandro Pluchino, Alessio Emanuele Biondo and Andrea Rapisarda won the Ig Nobel Economics prize for explaining, mathematically, why success most often goes not to the most talented people, but instead to the luckiest. Their study appeared in the journal *Advances in Complex Systems*. This was the second Ig Nobel awarded to Pluchino and Rapisarda. They and their colleague Cesare Garofalo won the 2010 Management prize for demonstrating mathematically that organisations would become more efficient if they promoted people at random.

Two hearts become one

The Applied Cardiology prize went to Eliska Prochazkova, Mariska Kret and their colleagues for finding evidence that when future romantic partners meet for the first time, and feel attracted to each other, their heart rates synchronise. (Kret has a history of curiosity-driven research. She was lead author of a 2016 study called "Getting to the bottom of face processing. Species-specific inversion effects for faces and behinds in humans and chimpanzees". That paper added humanity to the chimpanzees-only research that won the 2012 Ig Nobel Anatomy prize for Frans de Waal and Jennifer Pokorny.)

Scandinavian noir

Magnus Gens created a moose crash-test dummy, wrote his master's thesis about it in 2001 and has now been rewarded with the Ig Nobel Safety Engineering prize. What drove Gens? His thesis explains: "Scandinavia has a very large moose population and car-moose collision is a huge problem with many fatal outcomes."

And the rest

Eric Martínez, Francis Mollica and Edward Gibson won the Literature prize, for analysing what makes legal documents unnecessarily difficult to understand. They published their analysis, a carefully phrased 7000 or so words, in the journal *Cognition*.

The Biology prize went to Solimary García-Hernández and Glauco Machado. They studied whether constipation affects the mating prospects of scorpions and, if so, how. The scorpions' plight arises when they respond to a predator's attack by discarding their tail segments – an action called autotomy. García-Hernández and Machado explain: "After autotomy, individuals lose nearly 25% of their body mass and the last portion of the digestive tract, including the anus, which prevents defecation and leads to constipation." Despite which, love, or whatever you call it, finds a way.

The Medicine prize went to a team who found that when patients undergo some forms of toxic chemotherapy, they suffer fewer harmful side effects when ice cream replaces a traditional component of the procedure: sucking on ice cubes.

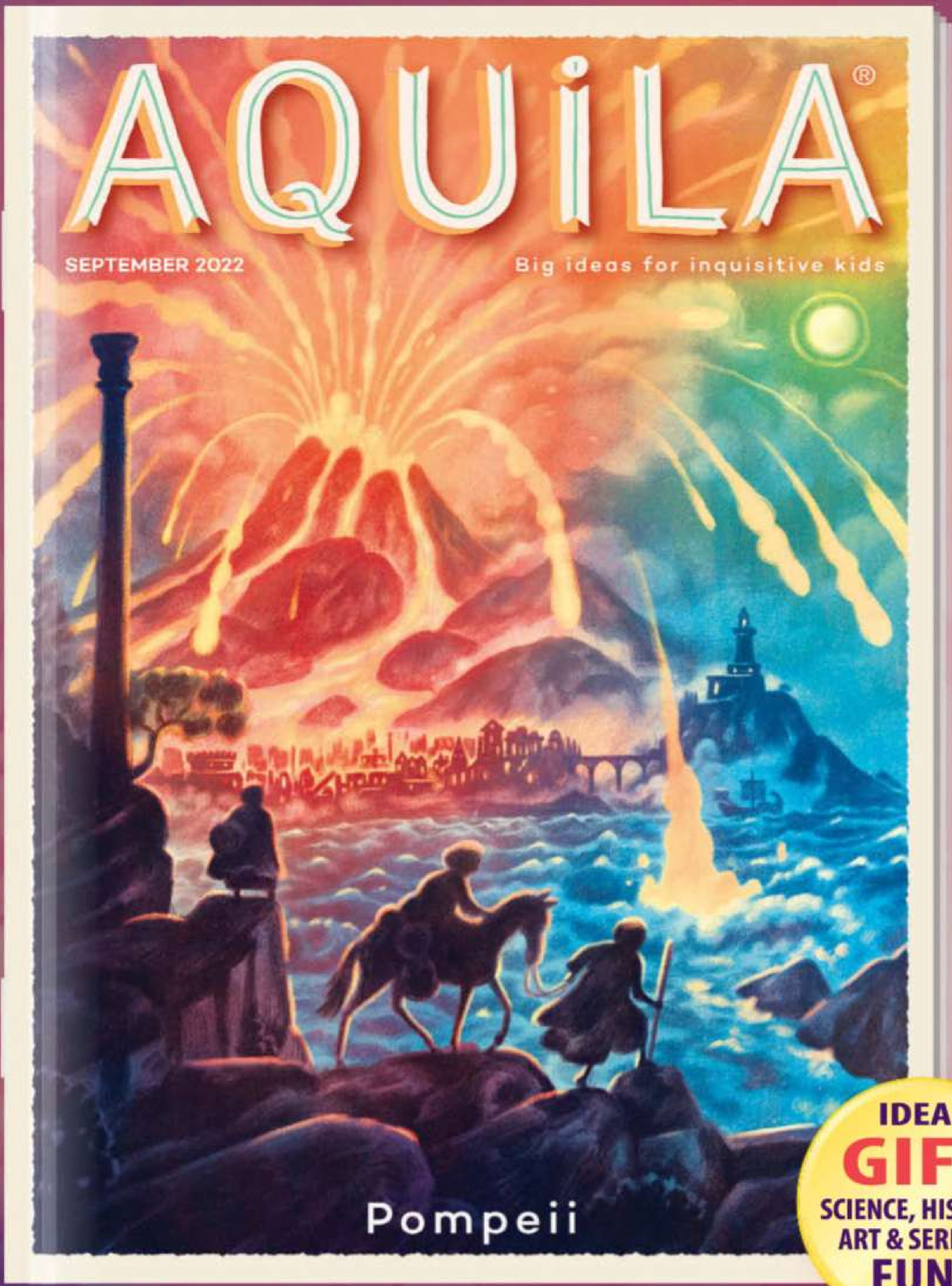
The Engineering prize honoured a methodical campaign to find the most efficient way for people to use their fingers when turning a knob. The winners' study, published in the *Bulletin of Japanese Society for the Science of Design*, extends our intellectual grasp of the question. It is called "How to use fingers during rotary control of columnar knobs".

The Art History prize celebrated the authors of a study called "A multidisciplinary approach to ritual enema scenes on ancient Maya pottery". Published in the *Journal of Ethnopharmacology* in 1986, it is perhaps the most extensively documented investigation that cleanly focuses on that topic.

And then there was the Peace prize, awarded to a group for their recent paper in the *Philosophical Transactions of the Royal Society B*. The team developed an algorithm to help gossipers decide when to tell the truth and when to lie.

The ceremony ended with its usual salute: "If you didn't win an Ig Nobel prize this year, and especially if you did, better luck next year!" ▮

AWARD-WINNING CHILDREN'S MAGAZINE



IDEAL GIFT SCIENCE, HISTORY, ART & SERIOUS FUN!

AQUILA MAGAZINE is a seriously intelligent publication that's written with a playful sense of humour. Every month there's a *beautifully illustrated* educational topic with first class *Science, Arts & General Knowledge* – and although AQUILA is perfectly designed for curious children of 8 – 14 years, many adults love reading it too!

SEPTEMBER: we visit *Pompeii* the day before the eruption. **OCTOBER:** join us for the *Spooky Issue!* **NOVEMBER:** drama lovers will adore *Show Stoppers*. **DECEMBER:** the *Winter Wild* issue marks the start of a fantastic Christmas gift!

"it informs, it educates, it entertains..."
The British Society of Magazine Editors 2021 – Winner Youth Category

Discover more here:
AQUILA.CO.UK
01323 431313

JOSEPH COOK,
GLACIOLOGIST

VRENI HÄUSSERMANN,
MARINE BIOLOGIST

MIRANDA WANG,
TECH ENTREPRENEUR

SONAM WANGCHUK,
ENGINEER

MARK KENDALL,
BIOMEDICAL ENGINEER

KRITHI KARANTH,
CONSERVATIONIST

BRUKTAWIT TIGABU,
EDUCATOR

BRAD NORMAN,
MARINE BIOLOGIST

GRÉGOIRE
COURTINE,
NEUROSCIENTIST

A FUTURE WORTH PIONEERING

Pioneers. Guardians. These men and women spend their life's energy striving for the preservation of our planet. They have identified some of its deepest wounds and ailments. They have designed unique solutions to save endangered species, to recycle plastic waste, to protect agriculture, to restore ecosystems, to improve living conditions… All bold, visionary programmes that they develop in all four corners of the planet, to make it perpetual. And since 1976, the Rolex Awards for Enterprise support these pioneers, the guardians of a future never certain, yet always worth reinventing. For a perpetual planet.
Rolex Awards for Enterprise.

#Perpetual

OYSTER PERPETUAL ROLEX DEEPSEA

ROLEX